THE KING'S RULE: MATHEMATICS AND DISCOVERY

Table of Contents

INTRODUCTION.....1

PROGRAM OBJECTIVES.....3

PROGRAM OVERVIEW.....4

Student Options.....5

Teacher Options.....5

DIFFICULTY LEVELS.....7

Level 1: The Castle Gate.....7

Level 2: The Guards' Room.....8

Level 3: The Game Parlour.....9

Level 4: The Magician's Study.....10

Level 5: The Royal Suite.....12

Level 6: The King.....14

BACKGROUND ON PLAYING.....16

CLASSROOM USE.....18

Apple: Working With the Computer.....20

Commodore 64: Working With the Computer.....21

TRS-80: Working With the Computer.....22

"What Happens If . . .?" Sunburst Courseware and Warranty.....23

THE KING'S RULE: MATHEMATICS AND DISCOVERY

Introduction

by Thomas C. O'Brien

THE KING'S RULE: MATHEMATICS AND DISCOVERY uses a captivating fantasy format to address skills at the very heart of scientific and mathematical reasoning: the generation and testing of hypotheses.

Let's take a simple example. Suppose someone says to you "1-2-3." Then the same person says "8-9-10." Next comes "34-35-36."

What's happening here? It might occur to you that the person is giving you three consecutive numbers. You have formed a hypothesis. How would you test this hypothesis? You might ask whether 5-6-7 fits the "rule" that person is using. If you were told "Yes, 5-6-7 does fit," you'd feel more secure about your hunch.

But 5-6-7, or even 8-9-10 and 34-35-36, have other common properties besides being three consecutive numbers. They are also three numbers with a constant jump (in this case, 1). Therefore, the numbers 104-108-112 (with a constant jump of 4) would also fit the rule.

So, you could ask whether 5-6-7 fits and you would increase your confidence in the hypothesis "three consecutive numbers." But if you had several hypotheses in mind, and if you sought both confirming and disconfirming evidence, you'd be much more likely to discover the correct rule.

Indeed, all of science, if not all of intelligent life, depends upon the generation and testing of hypotheses. We must not allow ourselves to be sold on the first idea that comes to mind. (Imagine a physician who considers one symptom, say a fever, and jumps to a diagnosis -- cholera -- without further inquiry. You wouldn't take your Pet Rock to such a person.)

Despite the importance of hypothesis generating and testing in science, mathematics, and other fields, it receives very little attention in our school curriculum.

THE KING'S RULE fills this void, providing rich experiences through which students develop critical thinking skills. The program is diverse enough to engage elementary students as well as adults.

It does so through a series of number riddles at six levels

of difficulty. Although the thinking at higher levels can get quite complex, the mathematical knowledge required of players does not exceed that of sixth grade math. In each game, players are given three numbers related by a "secret" rule. Players are then invited to try three numbers of their own to see whether or not the numbers fit the rule. Players can do this as long as they want. When they are satisfied that they have made a correct diagnosis, they can test their conclusions with a five-question quiz.

The program is based on the research of Professor P.C. Wason of the University of London. He researched a single rule ("three numbers in increasing order") with Harvard University students at Jerome Bruner's Center for Cognitive Studies. Wason used the numbers 2-4-6, and he cautioned students to gather as much evidence as possible before announcing the rule.

Given 2-4-6, students almost always asked questions of the type, "Does 4-6-8 fit the rule?" Of course the answer was yes. After a number of other such questions (e.g. 10-12-14), students commonly guessed the rule to be "three consecutive even numbers."

When told that it was not the rule (The rule was "three numbers in ascending order.) and given a second chance, students persevered with the 8-10-12 sort of question and "altered" their original hypothesis to "The first number is even, the second is two more, and the third is two more again."

In general, Wason found that these highly educated students failed to truly test their hypotheses by trying such samples as 2-4-5, 6-4-2, or 4-8-12. In publishing the research, he chose the title "On the Failure to Eliminate Hypotheses."

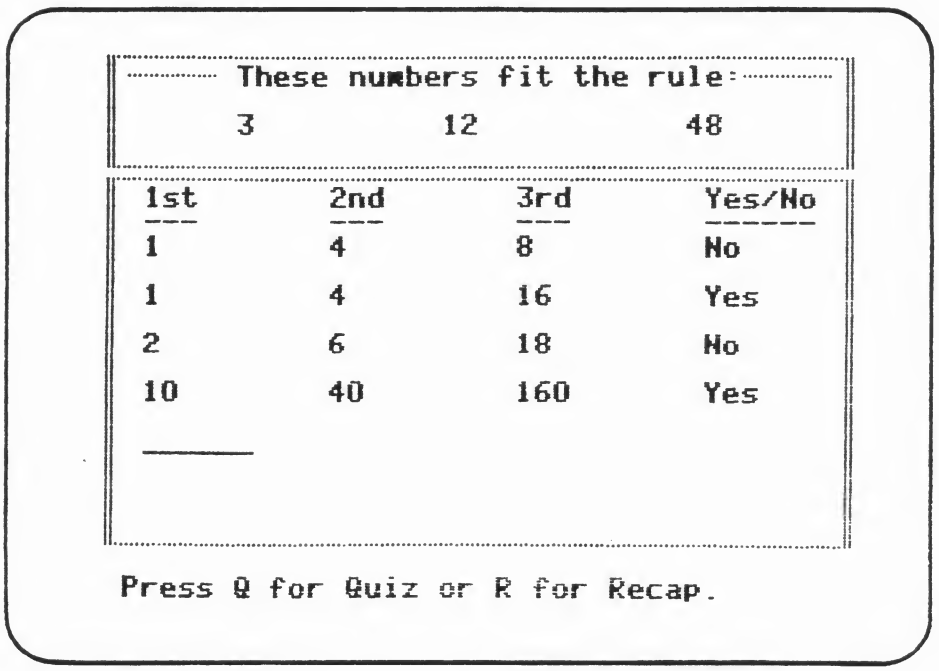
THE KING'S RULE thus helps students to build abilities which are 1) at the heart of scientific thinking, 2) not systematically attended to by present curricula, and 3) widely unavailable even to "well-educated" students.

The program helps its users learn to test alternate hypotheses in an attempt to find the truth. One or two initial quiz failures will quickly and brightly illuminate the benefits of that process:

"Gee, I thought I had the rule! But. . .if that's not it, then what else could it be . . . and how can I weed out the incorrect hunches in order to find the one that will work?"

Best of all, THE KING'S RULE is fun to play. It's even better in groups!

THE KING'S RULE: MATHEMATICS AND DISCOVERY



Skills: Recognizing numerical patterns and relationships
Addition, subtraction, multiplication, and division
Forming and testing hypotheses
Problem solving
Developing and using strategies

Grade Level: 6 - adult

Reading Level: 4th grade (Fry)

Time Required: 10 - 20 minutes for each level

Objectives:
1. To train students to form and test hypotheses.
2. To build skills in recognizing numerical patterns and relationships.
3. To develop skills in critical thinking and problem solving.

Program Overview

Students playing THE KING'S RULE solve number riddles -- guessing the rules that apply to sets of three numbers -- as they move from room to room inside a king's castle. The rooms correspond to difficulty levels. Students are allowed entrance into each room after they have solved three riddles at that level. Their ultimate objective is to come face-to-face with the King, deep within the fortress, where each player is challenged to solve a final series of riddles. To meet the King may take many sittings, even for a very able player.

The program has six levels of difficulty that correspond to five castle rooms and the challenge of the King. They are

Level 1: The Castle Gate
Level 2: The Guards' Room
Level 3: The Game Parlour
Level 4: The Magician's Study
Level 5: The Royal Suite
Level 6: The King

On each level, students are shown three numbers that correspond to a secret rule. They must generate their own hypotheses about the rule, and then test those hypotheses by entering their own sets of three numbers for the computer to check against the rule. The computer will respond "Yes" to those sets that conform to the rule, and "No" to those that don't. When students feel confident that they know the rule, they can take a quiz that tests their conclusions.

Students can enter the program on any level left open to them by the teacher (see the change option on page 5). After solving three consecutive riddles on Levels 1-3, or a total of three riddles on Levels 4-6, students are returned to the main menu, where they can choose to go to a higher (or lower) level.

If students fail a quiz by answering any of its questions incorrectly, they are given the choice of

1) again trying the same level/same rule,
2) trying the same level/different rule, or
3) returning to the main menu (to choose a lower level).

For more information on playing sequence, see page 16.

Students must press the RETURN key [Apple/Commodore] or ENTER key [TRS-80] for all inputs except for the student options listed in the next section.

Student Options

The following playing options are available to students during the program:

Recap Notepad

Students testing hypotheses may receive a recap of their previous guesses by pressing the R key when the computer asks for a number input.

Quiz Request

Students finished testing hypotheses may request a quiz by pressing the Q key when the computer asks for a number input.

Exiting the Program

Students may exit the program at any time by simultaneously holding the CONTROL and E keys (the SHIFT, down-arrow and E keys on the TRS-80) at any input.

Teacher Options

Two teacher options are provided to enrich your use of THE KING'S RULE.

The Change Option: Sound and Level Availability

By simultaneously pressing the T key with the CONTROL [Apple], SHIFT and down-arrow [TRS-80] or C= [Commodore] keys during the menu screen, you can

* add or delete the program's sound (not available on TRS-80), or
* open or close higher difficulty levels.

When the sound option is on, the program will emit "yes" or "no" tones along with displayed answers during the hypothesis testing segment of the program. In situations where the sounds would be distractive, the computer can be muted. The computer will remain in either mode until you use the option again.

The same option allows you to limit the level at which students can enter the program by selectively closing off higher difficulty levels. If you decide that Level 4 is the

highest at which students should be allowed to enter, you may specify so during the option and students will see only Levels 1-4 on the main menu. Students playing in this mode would still be able to advance to Level 5 by solving a total of three riddles at Level 4. They could choose to go back to the menu and would then see Levels 1-5 displayed. Likewise, students failing a quiz at Level 3, and then going back to the menu, would see only Levels 1-3 displayed.

Display the Rule Option

In Levels 3-6, you may press CONTROL and T [Apple], SHIFT, down-arrow and T [TRS-80] or and T [Commodore] during any hypotheses test screen in order to see the rule under which the program is currently operating. Two numbers will appear in the lower right-hand corner of the screen. The first number is the level; the second is the current rule being tested. You can then find that number and its corresponding rule in the rules section of this guide (page 7).

Difficulty Levels

Following are descriptions of each difficulty level, including the specific rules with examples. Although students may enter the program at any level left open by the teacher (see the change options on page 5), they should first be encouraged to work through the first three levels sequentially. Sequential play is not so important in Levels 4, 5 and 6, where rules, example sets, and strategies interact in entirely new ways. Students should be allowed free reign there.

Level 1: The Castle Gate

DESCRIPTION:

Rules in Level 1 involve small upward or downward jumps, from 1 to 10 inclusive, from the first number to the second to the third. All sets presented by the program in Level 1 are transparent. That is, they clearly suggest the rules that govern them.

EXAMPLES:

If the rule is "increasing jumps of 2," and the beginning number is 10, the resulting set would be

10 12 14.

A typical rule might also be "decreasing jumps of 2," with a beginning number of 14, in which case the same three numbers could be presented in descending order:

14 12 10.

If the rule is "decreasing jumps of 5," the program might present the set,

29 24 19.

Level 2: The Guards' Room

DESCRIPTION:

Rules found in Level 2 involve constant multiplication or division jumps of numbers between 1 and 9 inclusive. They are multiplied or divided by numbers between 1 and 5 inclusive. The sets presented by the program in Level 2 are also transparent: They clearly represent the rules that govern them.

EXAMPLES:

A "seed" value is chosen, such as 4. That number is then multiplied by a factor between 1 and 5 -- in this case, 2. The resulting product is then multiplied by the same factor again. The result is

4 8 16.

This relationship might also be displayed in descending order (representing a different rule -- that of numbers divided by 2):

16 8 4.

If the rule is "numbers multiplied by 5 -- ascending," the numerical example presented by the program could be

2 10 50

(the seed number, 2, then that number times the multiple, 5, then that product times the multiple). Students testing hypotheses of this rule could get acceptance on submissions such as 7-35-175 or 1-5-25. Submissions of 125-25-5 or 50-10-2 would not be accepted since they involve division by 5.

The following set indicates the rule "divide each succeeding number by 4":

48 12 3

(48 divided by four, then the resulting quotient divided by four, yielding 3). Students testing hypotheses for this rule could get acceptance for the submissions 64-16-4, 16-4-1, or several others.

Level 3: The Game Parlour

DESCRIPTION:

The rules in Level 3 include all of those used in Levels 1 and 2, with the addition of ten new rules. Again, each set presented by the program clearly suggests its rule. The ten new rules used in Level 3, along with a numerical example of each, are presented below:

1. Rule: All numbers end in 9.
   Example: 9 29 19

2. Rule: The third number is the sum of the first two.
   Example: 17 8 25

3. Rule: The third number is the product of the first two.
   Example: 6 8 48

4. Rule: All numbers are divisible by 5.
   Example: 25 10 25

5. Rule: All numbers are divisible by 3.
   Example: 12 6 18

6. Rule: All numbers are divisible by 10.
   Example: 70 100 20

7. Rule: The second number is larger than the first, but smaller than the third.
   Example: 1 2 6

8. Rule: The first number minus the second equals the third.
   Example: 18 12 6

9. Rule: All of the numbers are odd.
   Example: 13 17 7

10. Rule: The numbers have a common divisor ranging from 1 to 10.

    Example: 56 96 32 (divisor is 8)
             130 70 190 (divisor is 10)

NOTE: In addition to rules 1-10, a CONTROL-T rule check on this level might indicate

"3-11" (meaning a Level 1 / ascending rule),
"3-12" (meaning a Level 1 / descending rule),
"3-13" (meaning a Level 2 / ascending rule), or
"3-14" (meaning a Level 2 / descending rule).

Level 4: The Magician's Study

DESCRIPTION:

Level 4 calls for deep thinking. Here, the third number is the result of an operation --addition, subtraction, multiplication, or division -- involving the first two numbers, and in some cases, a constant. The following list of eighteen formulas shows how the rules are calculated:

A: random value from 1 to 9
B: random value from 1 to 9
C: a value ranging from 1 to 5, staying constant throughout study of the rule

The program uses INT (Integer) to mean ignore fractional parts.

(INT 4.3 = 4)

ABS (Absolute value) means ignore the negative sign.

(ABS -4 = 4)

Rule	First Number	Second Number	Third Number
1	A	B	A*B
2	A	B	A-B
3	A	B	A*A-1
4	A	B	B-A
5	A	B	A
6	A	B	A*A
7	A	B	(A-B)*(A-B)
8	A	B	INT (A+B/2)
9	A	B	(A+B)*(A+B)
10	A	B	ABS ($A^2 - B^2$)
11	A	B	-(A+B)
12	A	B	(A+1)*(B+1)
13	A	B	A+B+C

Level 4 (Continued)

Rule	First Number	Second Number	Third Number
14	A	B	(A*B)-C
15	A	B	(A+B)*C
16	A	B	(A*B)+C
17	A	B	100-A-B
18	A	B	(A+B)*10

EXAMPLES:

The program may present the set

2 4 8,

based on the rule, "multiply the first number by the second.

For the rule (A+B)*10, an example would be

2 3 50.

Level 5: The Royal Suite

Level 5 differs significantly from previous levels. Here, the example sets given by the computer may be deceiving in regard to the rules they represent. Therefore, it is especially important to critically test several different hypotheses. If the student is presented with the set 100-200-300, the rule may not be the obvious ("multiples of 100" or "jumps of 100"), but something not so obvious, such as "multiples of 2" or "multiples of 5."

Suppose the example set, 100-200-300, represents the latter rule "multiples of 5." Many players are likely to assume that the rule could be "multiples of 100," and may start the testing process by submitting other multiples of 100, such as 300-400-500. Since these numbers are also multiples of 5, the test sets would be approved. When presented with the quiz, players might then be asked to approve or reject the numbers 100-200-45. They might think "those numbers are not multiples of 100," and accordingly reject the set. Such an answer would be incorrect, and the players would fail the quiz. A better strategy would have been to test for the rules "multiples of 10," "multiples of 5,""multiples of 2," and others. In Level 5, students must be constantly on guard against being misled, although the computer will always tell the truth.

Following are the guidelines for each "disguised" example given by the program, and the actual rule each represents:

1. Example: Three consecutive even numbers
   Rule: The second number is greater than the first, but less than the third.

2. Example: Three consecutive even numbers
   Rule: The three numbers are even.

3. Example: Three consecutive odd numbers
   Rule: Any constant difference between the three numbers

4. Example: Three consecutive numbers
   Rule: The sum of the numbers is divisible by 3.

5. Example: Three consecutive multiples of 5
   Rule: Numbers in upward jumps of five (e.g. 2-7-12)

6. Example: The third number is 10 minus the sum of the first two numbers.
   Rule: Same as example

7. Example: Three multiples of 100
   Rule: Each number is divisible by 5.

Level 5 (Continued)

8. Example: Three consecutive multiples of 10
   Rule: The sum of the numbers is divisible by 10 (e.g. 8-3-9).

9. Example: The second number is five times the first. The third number is five times the second.
   Rule: Any three ascending or descending numbers

10. Example: The first and second numbers are multiples of 10. The third number is the sum of the first two.
    Rule: The third number is the sum of the first two.

11. Example: The second number equals the third. The first number is the second number times the third.
    Rule: At least two of the three numbers are equal.

12. Example: The first number is a multiple of three. The second number is the first plus 2. The third is the second plus 2.
    Rule: The sum of the numbers is divisible by 3.

13. Example: The first number ends with a 9; the second with an 8; the third with a 7.
    Rule: Same as example

14. Example: The first number is even. The second number is even. The third number is the first times the second.
    Rule: The third number is divisible by the first two.

15. Example: The first number is even. The second is twice the first. The third is three times the first.
    Rule: The second number is greater than the first but less than the third.

16. Example: The first number is a multiple of 3. The second number is the first plus 3. The third is the second plus 3.
    Rule: Any constant upward or downward jump

17. Example: The third number is the first number squared plus the second number squared.
    Rule: Same as example

18. Example: The three numbers are all even.
    Rule: The sum of the numbers is even.

19. Example: The second number is two times the first. The third number is two times the second.
    Rule: The numbers are in ascending order.

Level 6: The King

Level 6 uses very simple rules, but is extremely challenging because the rules may apply to only one or two of the numbers presented by the computer. For example, the program may present 64-66-68 and the rule would be "the second number is even."

Following are the guidelines for each "disguised" example given by the program, and the actual rule each represents:

1. Example: The first number is a multiple of 100 plus 1. The second number is the first plus 1, and the third is the second plus 1.
   Rule: Only one number is even.

2. Example: The first number is a multiple of 100. The second number is the first plus 1. The third is the second plus 1.
   Rule: Exactly one number can be evenly divided by 5.

3. Example: The first two numbers add up to 10.
   Rule: Same as example

4. Example: The second number is 1. The third is the same as the first.
   Rule: The second number is a square.

5. Example: The first number ends with a 3; the second with a 4; the third with a 5.
   Rule: At least one of the numbers ends with a 3.

6. Example: The third number is a constant ranging from 1 to 20 less the sum of the first two.
   Rule: Same as example

7. Example: The first number is a multiple of 4. The second number is the first plus 1. The third is the second plus 1.
   Rule: At least one number is divisible by 4.

8. Example: The first number ends with a 9, the second with a 0, the third with a 1.
   Rule: At least one number ends in nine.

9. Example: The first and third numbers are the same. The second number is the first plus 1.
   Rule: At least two of the numbers are equal.

Level 6 (Continued)

10. Example: The second number equals the first. The third number is the first times the second.
    Rule: All three numbers are either even or odd.

11. Example: The third number is the square of the sum of the first two.
    Rule: The third number is the largest.

12. Example: The first number is even. The second number is the first plus 1. The third is the second plus 1.
    Rule: At least one number is even.

13. Example: The first number is a multiple of 1000. The second number is the first plus 1. The third is the second plus 1.
    Rule: Only one of the numbers is divisible by 10.

14. Example: All three numbers are equal.
    Rule: The third number is the average of the first two.

15. Example: Each of the three numbers has the form ABC,ABC (typical sets presented by the computer would be 947,947 - 345,345 - 169,169 or 12,012 - 321,321 - 2,002).
    Rule: At least one number is divisible by 13.

16. Example: The third number is the square of the sum of the first two.
    Rule: Same as example

17. Example: The first number is the square of an even number. The second is the first plus 2; the third is the second plus 2.
    Rule: The second number is even.

18. Example: The third number is the square of the first.
    Rule: The third number is the largest.

19. Example: The first number is a multiple of 4. The second is the first minus 1. The third is the second minus 1.
    Rule: The first number is the largest.

20. Example: The first number is a square of an even number. The second is a square of an even number. The third is the average of the first two.
    Rule: The first number is a square.

Background on Playing

The program begins with an illustration of the castle. A menu then appears, and students choose the difficulty level (castle room) on which to begin. If the teacher has used the option of closing off higher levels (see page 5), only those levels eligible for play will appear on the menu.

As students work through the castle, they are met at the entrance to each room by a guard. Students are presented with the message, "Halt! I am the guardian of the ... room. To pass, you must successfully solve three number riddles." Students are then given a set of numbers that fit the secret rule, and may then form and test various hypotheses by submitting an unlimited number of sets for the computer to check against the rule.

Based upon the program's responses ("Yes [Those numbers fit the rule.]" or "No [Those numbers do not fit the rule.]"), the students test hypotheses until they feel ready for the quiz. At any time, students can get a recap of previous submissions by pressing the R key. Students having difficulty in successfully selecting numbers that fit the rule (three to six "No"s) will be given a hint in the form of another set that also fits the rule.

Students can call for a quiz by pressing the Q key at any input during the hypotheses-testing activity. They are then presented with five sets, and must say whether or not each one fits the rule. In Level 4, The Magician's Study, students taking the quiz are given two numbers that fit the rule -- they must enter the third.

After correctly answering all five quiz questions, students pass the quiz and, depending upon the level, the screen displays one of the following objects:

The Castle Gate (Level 1)	--	Key
The Guards' Room (Level 2)	--	Shield
The Game Parlour (Level 3)	--	Chess Piece
The Magician's Study (Level 4)	--	Magic Book
The Royal Suite (Level 5)	--	Flag

After passing three consecutive quizzes on Levels 1-3, or a total of three quizzes on Levels 4-6, students are granted passage into the room (or, on Level 6, win the game). They then are returned to the main menu, where they can select a higher (if applicable) or lower level. Students failing a quiz may choose to try the same riddle again, try another riddle at the same level, or try riddles at lower levels.

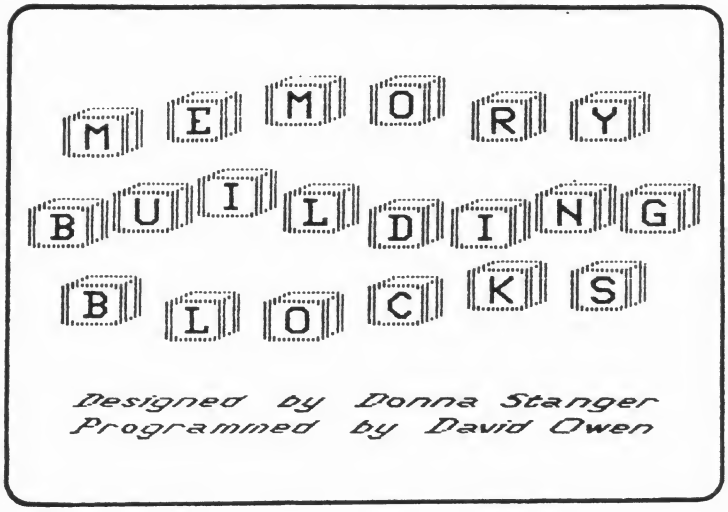
In this way, students progress toward the ultimate goal, solving a riddle at the highest level of difficulty -- The King. There an illustration of the witty and powerful monarch accompanies the climactic "Guess My Rule!" challenge. Each time students win a quiz, they are presented with a royal crown. When they win three crowns, they win the game.

MEMORY BUILDING BLOCKS: STRATEGIES THAT WORK

TABLE OF CONTENTS

	Page
Introduction	1
The Problem Solving Skill Matrix	3
Program Description	4
Change Options: Keyboard/Muppet Learning Keys/ Touch Window	9
Lessons for Classroom Use	10
President or Vacuum Cleaner	11
Create it Yourself	17
Visual Association - Software Strategy Lesson	21
Rhythm Memory	23
Speeds of Animals	25
Word Lists I and II	29
Creating a Context - Software Strategy Lesson	36
I Packed A Trunk	38
Chaining Along	40
Chaining - Software Strategy Lesson	42
Working With Your Computer Apple II	45
Apple IIGS: Control Panel Settings	46
Commodore 64	47
Working With Your Touch Window	48
Working With Your Muppet Learning Keys	49
"What Happens If...?" Sunburst Courseware and Warranty	50

PROGRAM DESCRIPTION



STRATEGIES:	Creating a context, visual association, sequence (chaining)
GRADE:	Kindergarten - Adult
SUBJECT AREA CORRELATION:	Any in which memorization is used.
READING LEVEL:	3rd grade for directions
TIME REQUIRED:	5-10 minutes (varies with the game board selected).

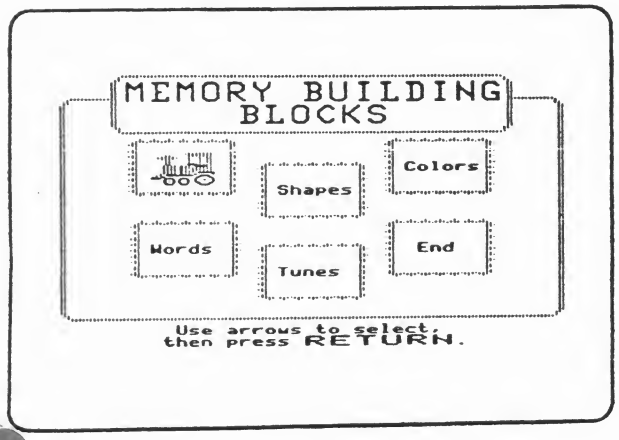
MEMORY BUILDING BLOCKS can be used by players of all ages (K-adult) depending on the game version and game board selected. The lessons included are designed for grades 3-6 but can easily be adapted for other levels.

To play the game, students must remember <u>what</u> they saw and <u>where</u> they saw it as they try to find matching pairs hidden under blocks on a game board. Students choose from 9 different game boards containing from 8 to 12 blocks. Five versions of the game include: "Things" (pictures), "Shapes," "Colors," "Words," and "Tunes."

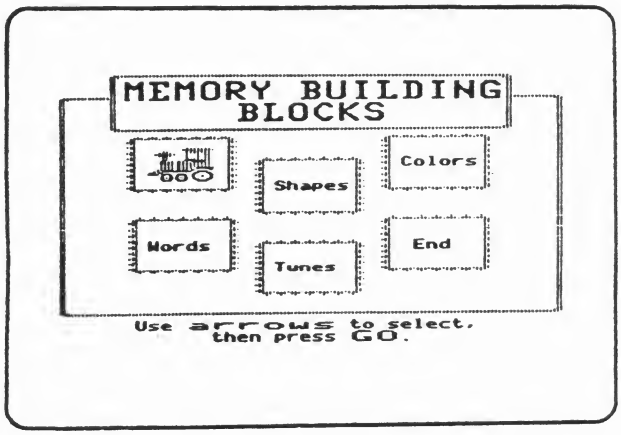
MEMORY BUILDING BLOCKS works with a variety of input devices:
On the Apple - keyboard, Muppet Learning Keys, Touch Window;
On the Commodore 64 - keyboard, Muppet Learning keys.
(See "Working With Your Touch Window," page 47 or "Working With Your Muppet Learning Keys," page 48). The teacher sets the program for the input device from the CHANGE OPTIONS, (see page 9).

Students begin by selecting the version they want to play from the main menu.

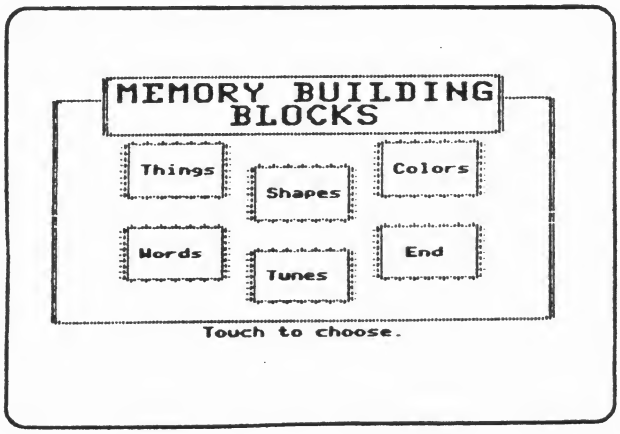
KEYBOARD



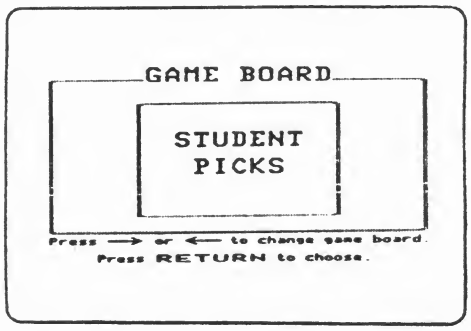
MUPPET LEARNING KEYS

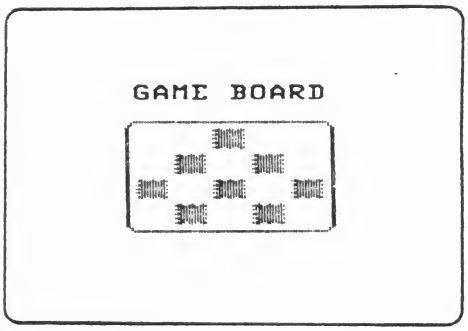


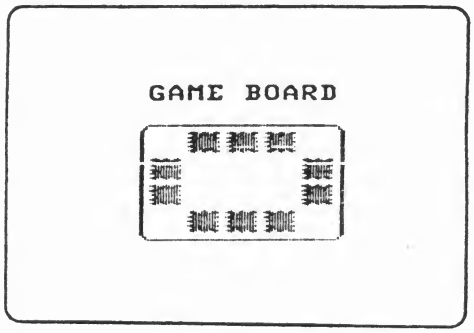
TOUCH WINDOW

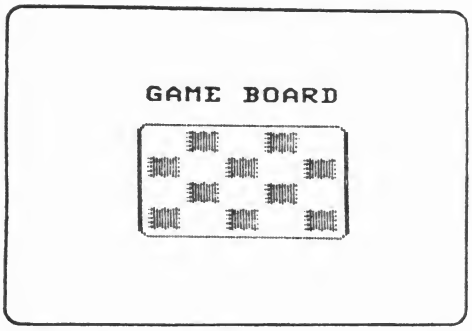


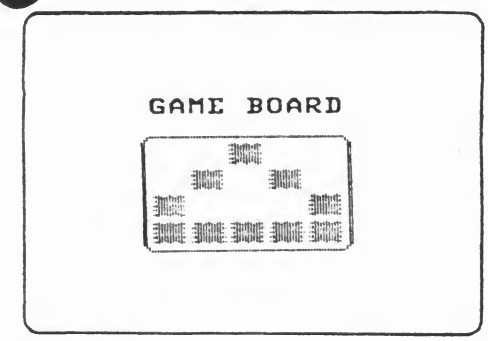
Next, (if the teacher has set the game board option to "Student Picks") the student is offered a choice of game boards. Nine different game boards are available.

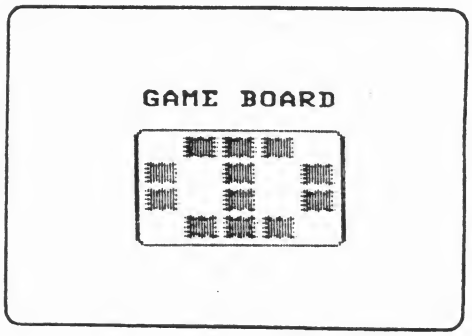


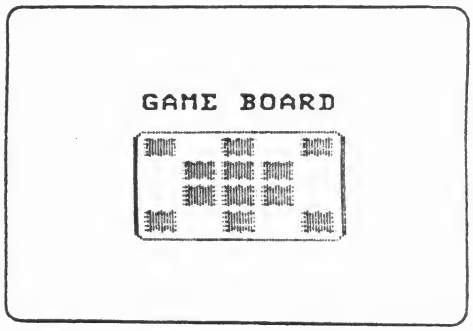


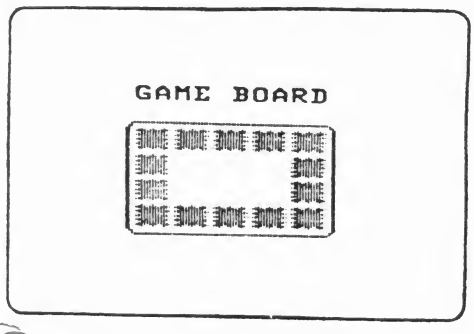


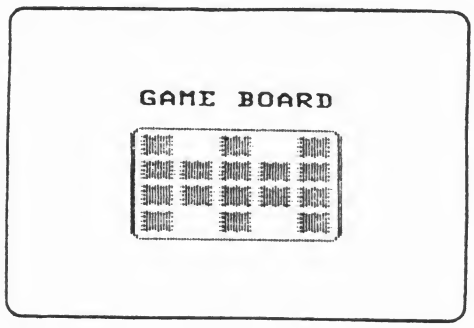


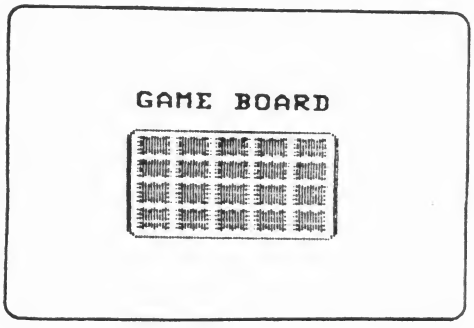








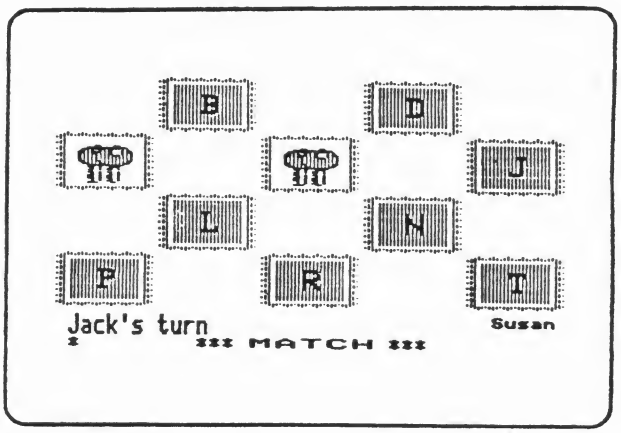




If the teacher has set the game board option to a specific board rather than to "Student Picks," the student will not be offered a choice of game boards.

The student will then have an opportunity to see the directions and to indicate whether there are 1 or 2 players.

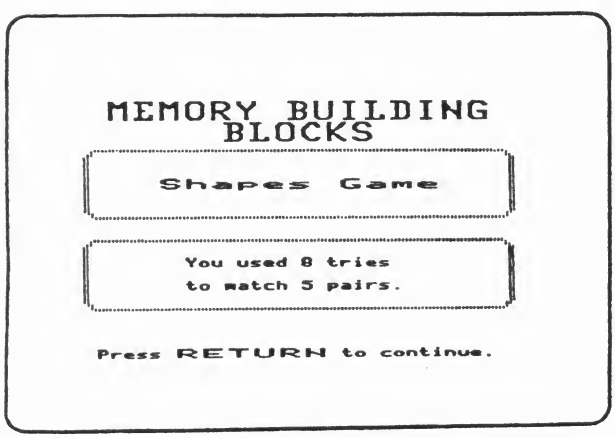
To play, students move two blocks per turn, looking for two hidden things that "match."



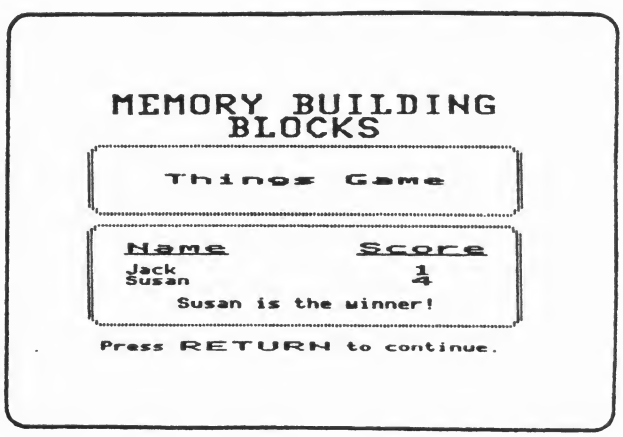
When a match is made, an audio response is given, unless the teacher has turned off the sound from the CHANGE OPTIONS (see page 9).

When a game has been completed a score screen is shown.

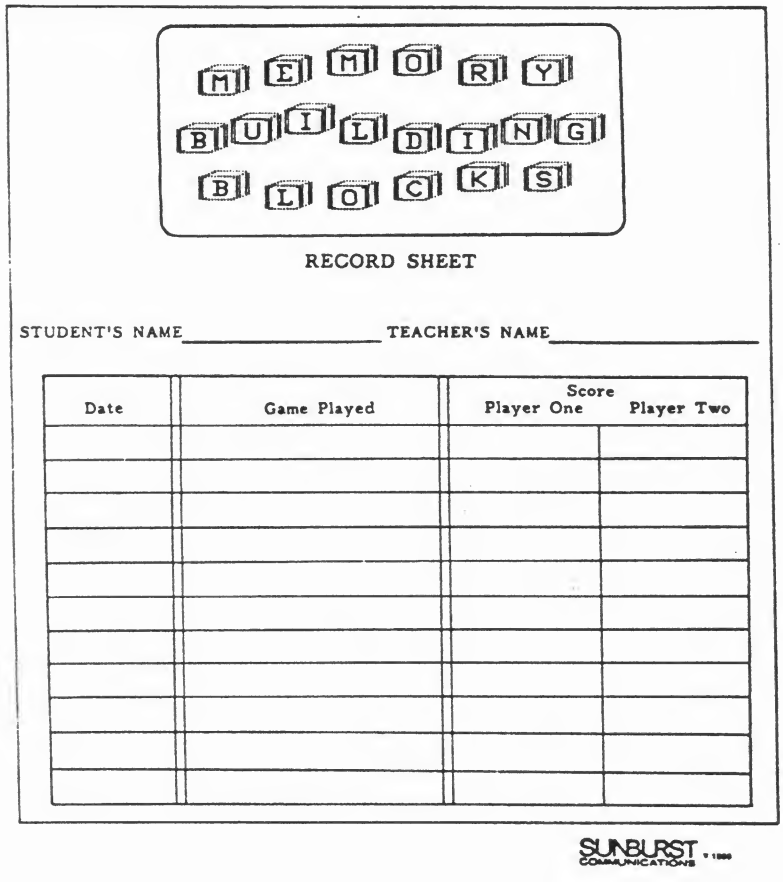
ONE PLAYER GAME



TWO PLAYER GAME



Scores from the score screen can be recorded on the Student Record Sheet.



MUPPET BUILDING BLOCKS

RECORD SHEET

STUDENT'S NAME_____ TEACHER'S NAME_____

Date	Game Played	Score Player One	Player Two

SUNBURST COMMUNICATIONS

Note: You may exit the game and return to the menu at any time.

On the Apple, hold down the Control key while you press "E."

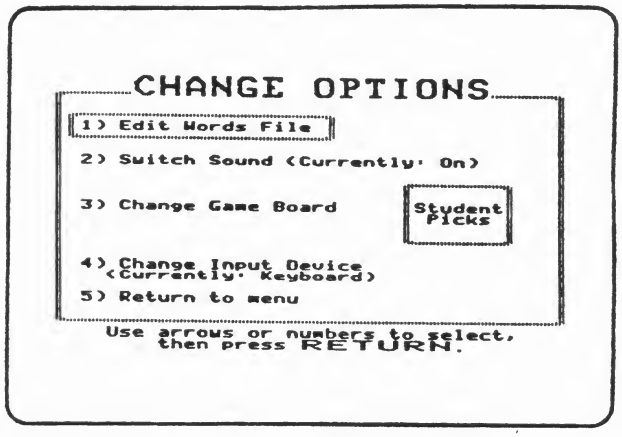
On the Commodore 64, hold down the Control key while you press "E."

On the Muppet Learning Keys, press "ZAP."

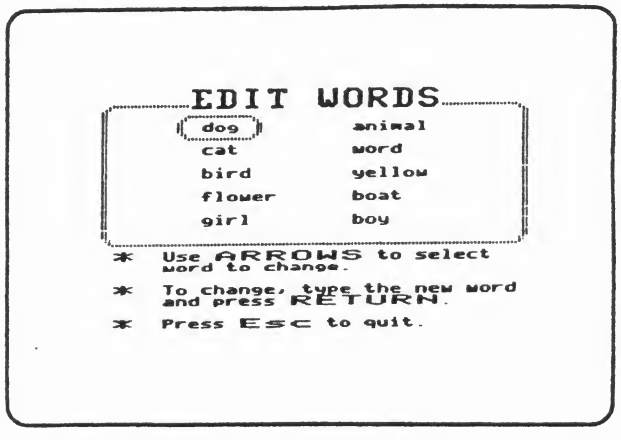
On the Touch Window, hold down the Control key while you press "E," or press one of the buttons on the lower edge of the window.

CHANGE OPTIONS

The CHANGE OPTIONS menu is accessed by holding down the Control key and typing "T" while the main menu is being displayed. On a Commodore 64, hold down the Commodore key while you type "T."


CHANGE OPTIONS
1) Edit Words File
2) Switch Sound (Currently: On)
3) Change Game Board
Student Picks
4) Change Input Device (Currently: Keyboard)
5) Return to menu
Use arrows or numbers to select, then press RETURN.

1. Edit Words File - allows you to change the words used in the "Words" game to fit your special classroom needs. Each word can be up to six characters long.



2. Switch Sound - allows you to turn the sound on or off. The sound must be on in order to play the "Tunes" game.

3. Change Game Board - You may select one of 9 different game boards or select "Student Picks" to allow the student to choose the game board.

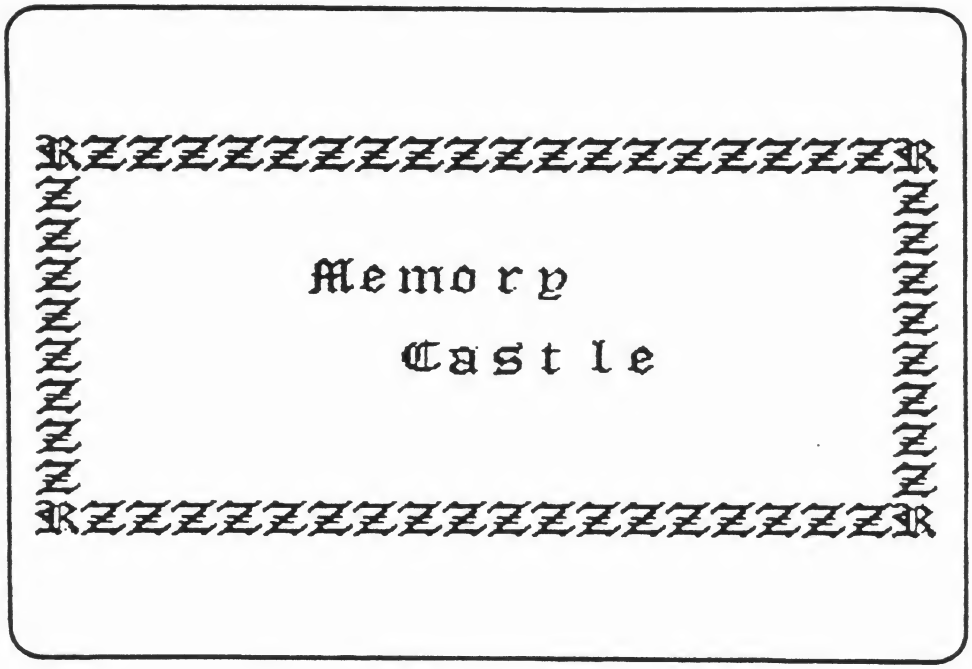
4. Change Input Device - allows you to set the input device to keyboard, Muppet Learning Keys or Touch Window.

TABLE OF CONTENTS

MEMORY CASTLE

	Page
Introduction	1
The Problem Solving Skill Matrix	3
Program Description	4
Remember Houdini - Classroom Lesson 1	8
Packing - Classroom Lesson 2	11
Remember the Planets - Classroom Lesson 3	19
Tallest Buildings in the U.S. - Classroom Lesson 4	23
How Long Do Animals Live? - Classroom Lesson 5	28
Learn the System - Classroom Lesson 6	33
Going Shopping - Classroom Lesson 7	45
Lincoln/Kennedy - Classroom Lesson 8	53
Historic Events - Classroom Lesson 9	57
Software Lesson	61
Apple II: Working With Your Computer	64
Apple IIGS: Control Panel Settings	65
IBM PC/PCjr: Working With Your Computer	66
Acorn: Working With Your Computer	67
Commodore 64: Working With Your Computer	68
TRS-80: Working With Your Color Computer	69
"What Happens If...?" Sunburst Courseware and Warranty	70

PROGRAM DESCRIPTION



SKILL OR STRATEGY: Personalization, Creating a Context, Mnemonic System

GRADE: 4th grade to adult

SUBJECT AREA CORRELATION: Any in which memorization is used

READING LEVEL: 5th grade

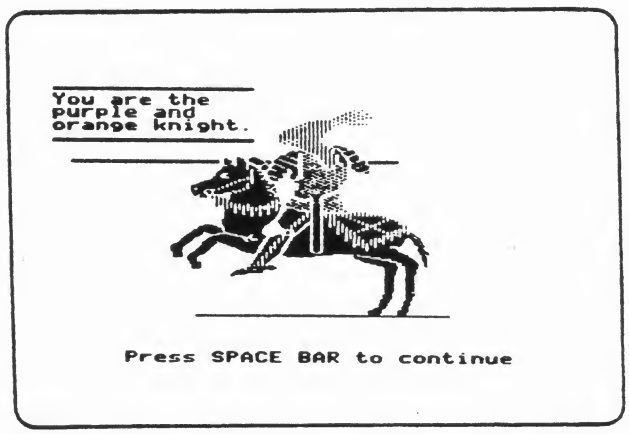
TIME REQUIRED: About six minutes per game

The classroom activities included were designed for students in grades 4-6, but with some modification could be used with older students as well. The software is appropriate for 4th graders to adult. MEMORY CASTLE provides students with practice in remembering specific instructions. Students work with sets of instructions which they must remember in the order given to successfully progress from one room in a castle to another. Students may select from three levels of difficulty with each level containing a set of instructions randomly selected by the computer. The object of the game is to remember all the instructions in the order they were given.

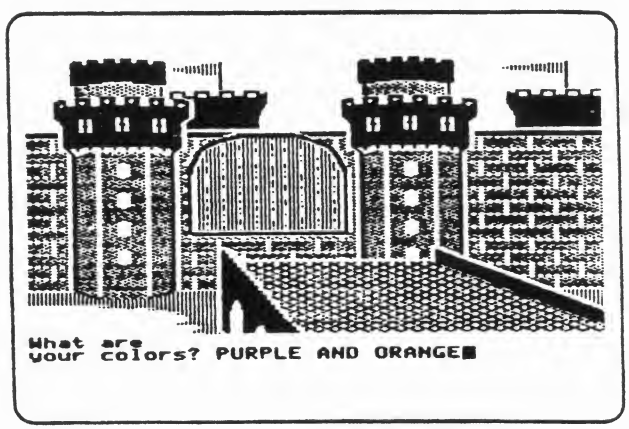
MEMORY CASTLE is preceded by a color test. Because parts of this game are enhanced by color, it is important to use this test to adjust the monitor or television. If you are using a TRS-80 color and the colors displayed are wrong, press the RESET button on the back of your computer.

MEMORY CASTLE begins with an option to see the directions for the game. The directions explain the need to choose an EASY (6 instructions to remember), MEDIUM (12 instructions to remember), or DIFFICULT (20 instructions to remember) assignment. Each instruction will tell WHERE to go, and WHAT to do. For example: Go to the kitchen and eat an apple. If all of the assignment is remembered in order, the student wins. If something is forgotten, the game will end.

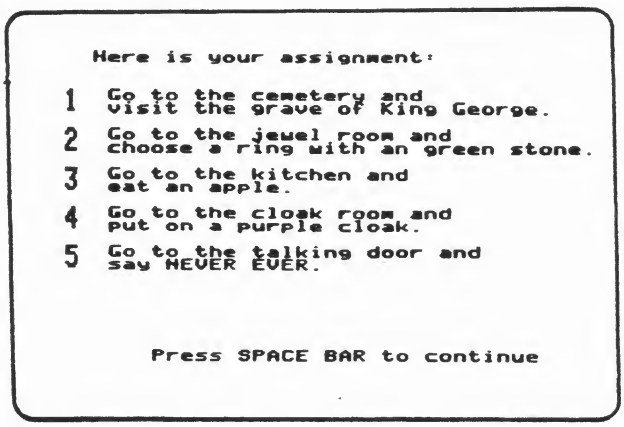
Following the directions, a knight wearing two colors is shown:



After selecting the level of difficulty, the colors of the knight must be entered.



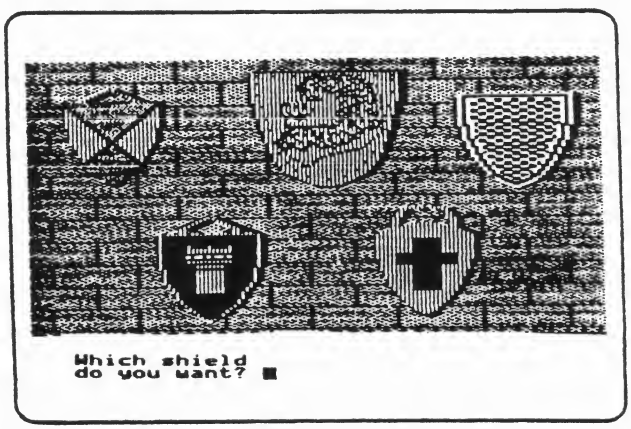
If an incorrect answer is given, the student is not allowed to enter the castle and must begin the game again. If a correct answer is given, the assignment is shown.


Here is your assignment:
1 Go to the cemetery and visit the grave of King George.
2 Go to the jewel room and choose a ring with an green stone.
3 Go to the kitchen and eat an apple.
4 Go to the cloak room and put on a purple cloak.
5 Go to the talking door and say NEVER EVER.
Press SPACE BAR to continue

The assignment may be studied as long as desired before continuing the game. The next question to be answered is "Where do you want to go?" Using what is remembered from the assignment, the student enters the first "place" to go.

- If the place to go is misspelled or not one of the possible places, the student is shown a list of places in the castle and allowed to continue.
- If a wrong place is entered, the correct answer is given and the game ends.
- If the correct place is entered, the game continues.

The student is shown the first place and asked a question.



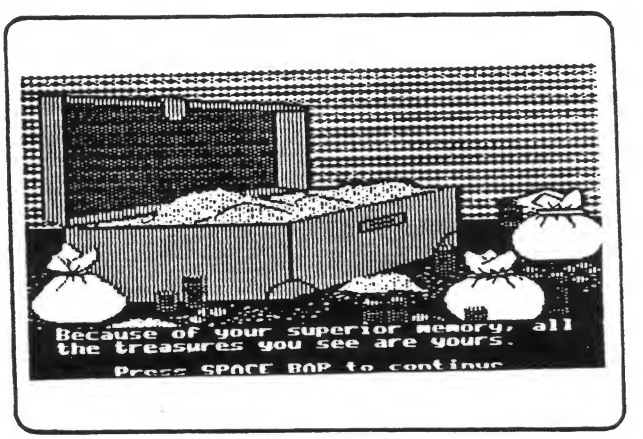
- If the question is answered correctly, the game continues by asking "Where do you want to go?"

- If the question is answered incorrectly, the correct answer is given and the game ends.

- If the answer to the question is misspelled or not recognized by the program, the student is asked "What do you mean?" and told to "Please try again." After receiving this message three times, the correct answer is given and the game ends.

When a game ends because of a mistake, the student is given an opportunity to see the assignment again. The student may also choose to play the game again using the same assignment.

Correct answers take the student from place to place until the assignment is completed. Completing an EASY assignment earns a Golden Goblet, a MEDIUM assignment earns the Royal Order of the Torch, and a DIFFICULT assignment earns a Room Full of Treasure.



Note: To stop playing before a game is completed, hold down the Control (CTRL) key while you press "E." (On a TRS-80 Color, hold down the down-arrow and shift keys while you press "E.")

MEMORY MACHINE

TABLE OF CONTENTS

Page

Introduction 1

Problem Solving Skill Matrix 2

Program Description 3

Change Options. 11

Lessons for Classroom Use. 12

Sign Language. 13

Shaping Up 19

Shapes to Words - Software Lesson 25

Picture Perfect. 28

Pictures to Words - Software Lesson. 38

Draw With Directions. 40

That's Crazy! 45

Paper Chaining 52

Words to Pictures/Words to Shapes - Software Lesson 62

Memory Improvement Products 65

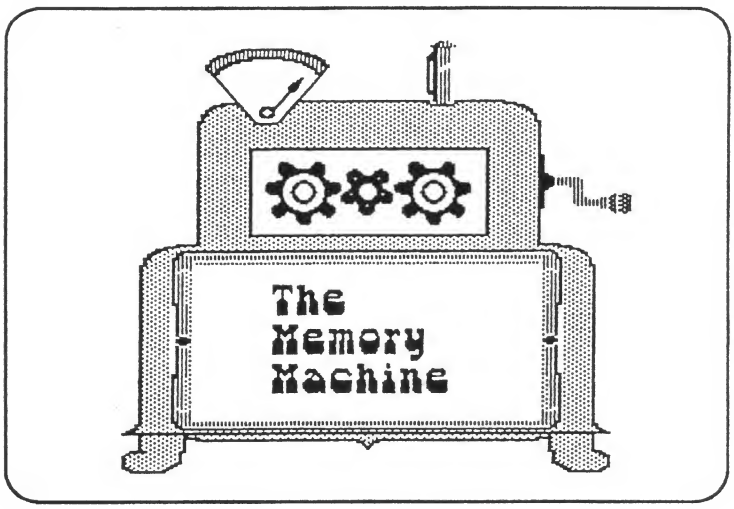
Working With Your Computer

Apple II: Working With Your Computer 66

Apple IIGS: Control Panel Settings 67

"What Happens If...?"
Sunburst Courseware and Warranty 68

PROGRAM DESCRIPTION



STRATEGIES:	Whole to part Visual association Sequence (chaining)
GRADE:	5th grade to adult
SUBJECT AREA:	Any in which memorization is required
READING LEVEL:	4th grade
TIME REQUIRED:	5 - 10 minutes per activity

Memory Machine, designed for 5th grade to adult, includes four activities requiring memory:

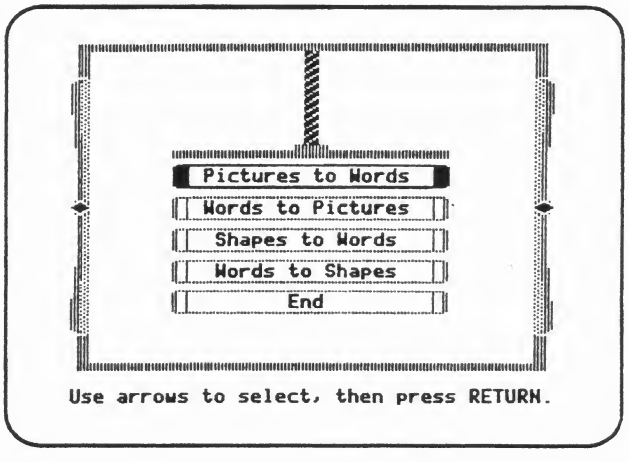
Pictures to Words . . . Details of a picture must be remembered.
Words to Pictures . . . A description of a picture must be remembered.
Shapes to Words . . . A set of shapes must be remembered.
Words to Shapes . . . A description of a set of shapes must be remembered.

The classroom lessons included introduce a variety of memory strategies (chaining, whole to part, visual association) which can be effectively used with the software. These lessons are written for grades 5 - 8, but can be easily adapted for other levels.

Instructions on how to use your Apple computer are on pages 66 - 67.

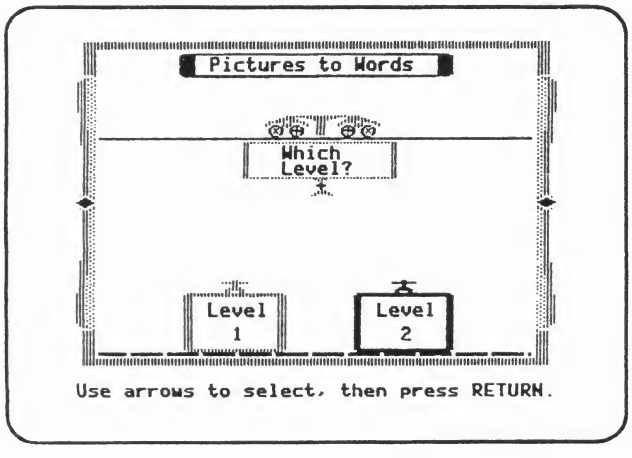
Note: *Pictures to Words* and *Words to Pictures* are color dependent and may present a problem for color-blind students. There are two possible solutions:
1) A color-blind student may be paired with one who is not, so that the student with normal vision can provide information as needed.
2) The teacher may use the Change Options (see page 11) to select the version for a monochrome monitor. This version eliminates the color-dependent portions of the activities.

Students begin by selecting the desired activity from the main menu.

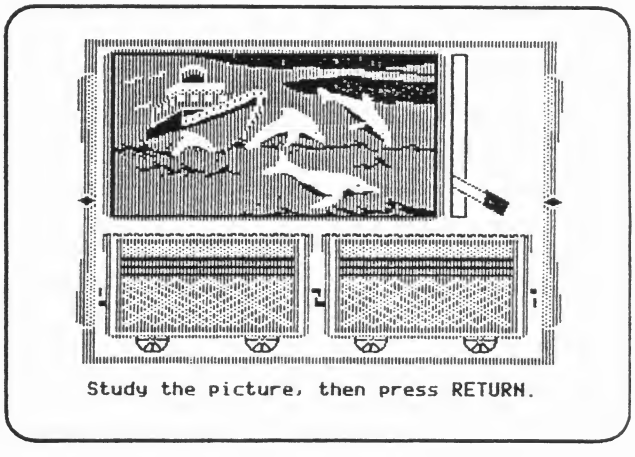


Pictures to Words

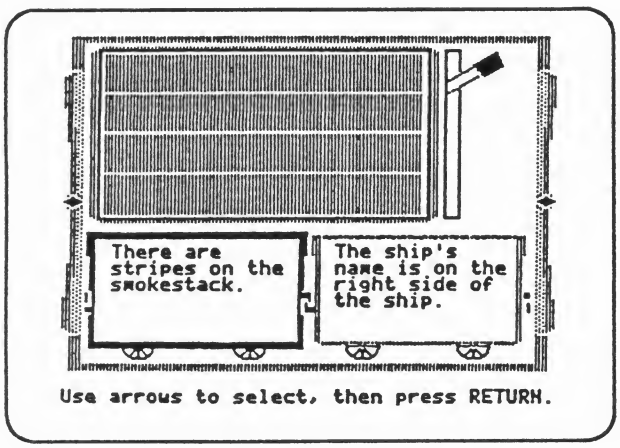
Students are first asked to select a level of difficulty. Students selecting Level 2 will be shown pictures with more details.



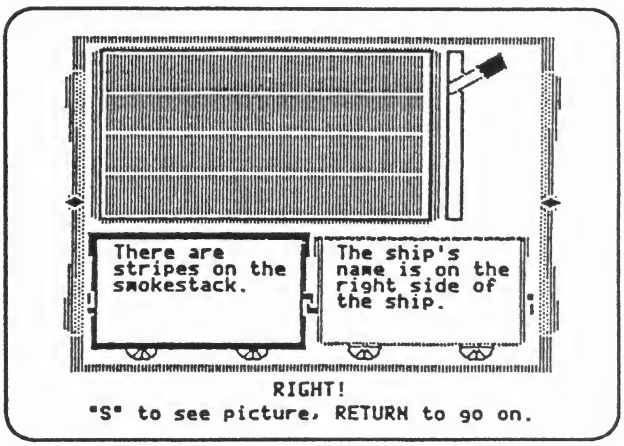
To play, students are shown a picture and asked to study it.



After studying the picture, the students are presented with two statements and asked to select the statement which correctly describes the picture.

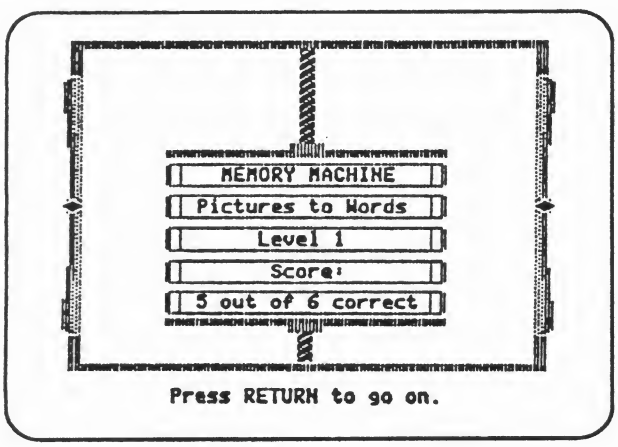


Students are told if their answer is correct and then given the option of seeing the picture again before continuing.

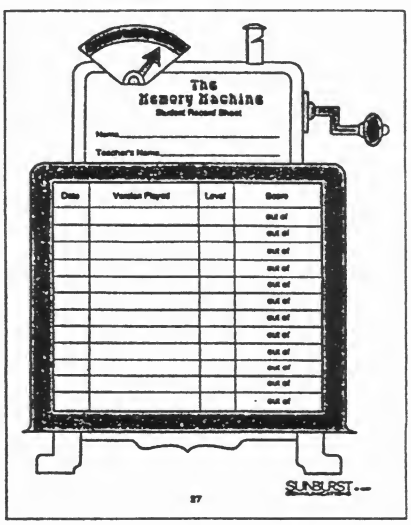


Note: In this program "right" and "left" are always used from the perspective of the viewer.

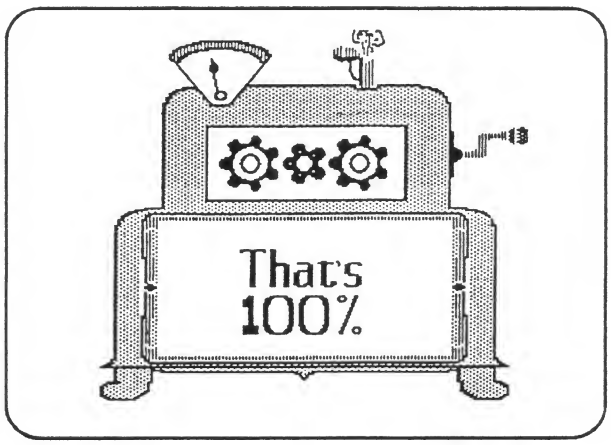
Following a total of three pictures, each with two sets of descriptive statements, a score screen appears.



Scores from the score screen can be recorded on the Student Record Sheet (page 27).



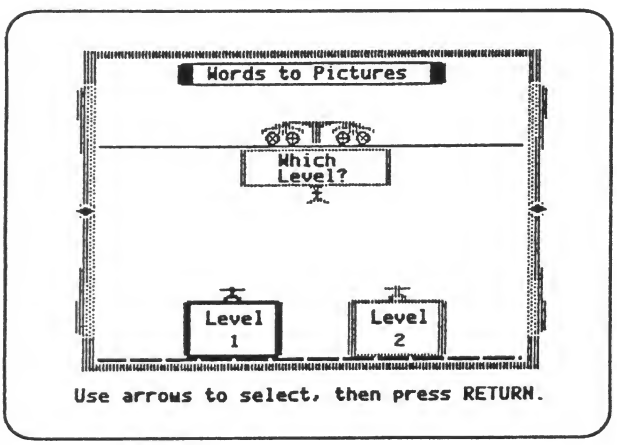
The Memory Machine operates (crank turns, gauge moves, gears spin, display changes, whistle blows) to reward students with perfect scores.

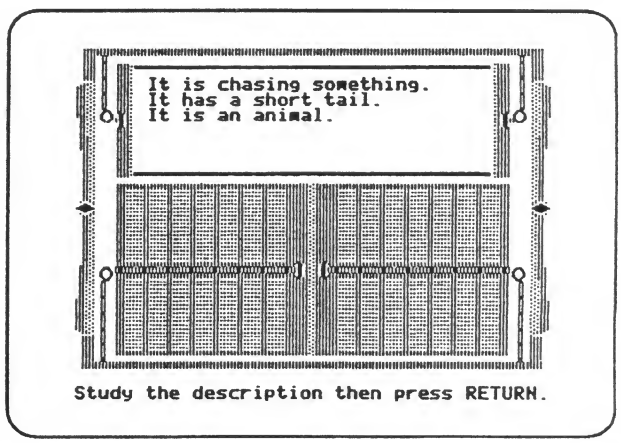


Words to Pictures

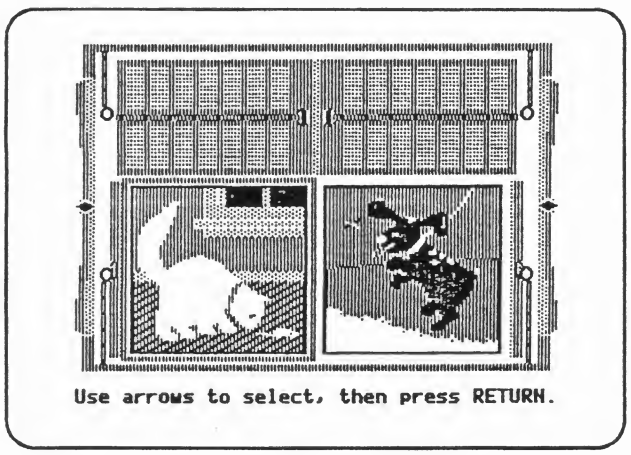
Words to Pictures begins with students selecting a level of play. Students selecting Level 1 will be shown simpler descriptions.

Next, students are shown three statements that describe a picture or an object in a picture. They are asked to study the description.

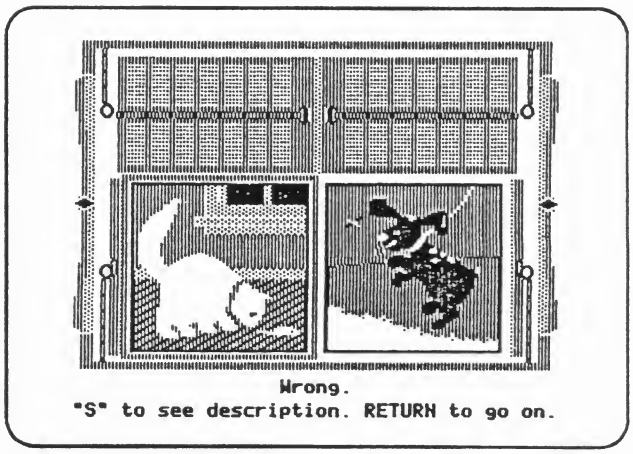




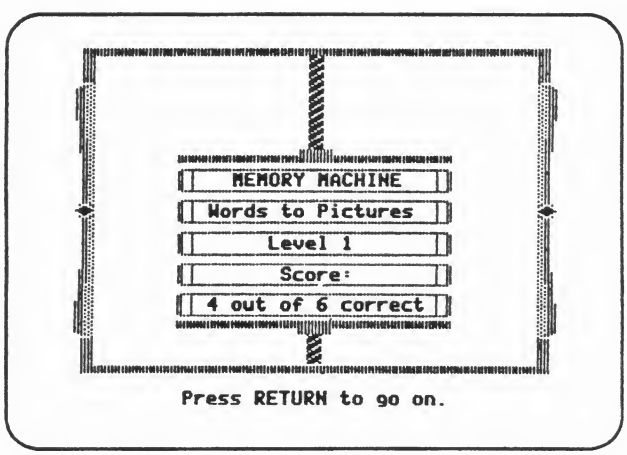
Students are then shown two pictures and asked to select the one that fits the description.



Students are told if their answer is correct and given the option of seeing the description again before continuing.

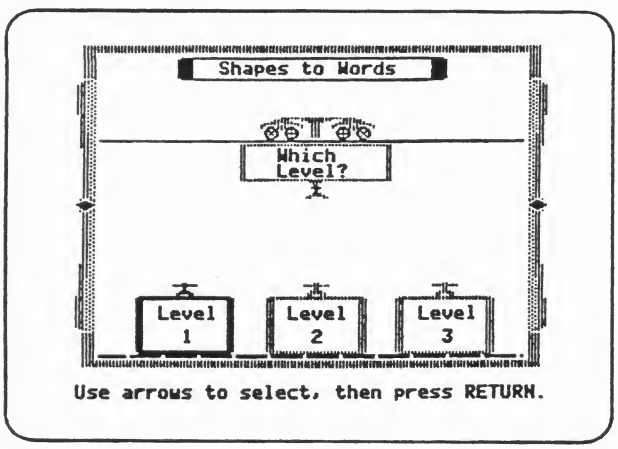


After students have identified the pictures for 6 different descriptions, a score screen is shown. Scores from the score screen can be recorded on the Student Record Sheet (page 27). The Memory Machine operates (whistles, etc.) to reward students with perfect scores.

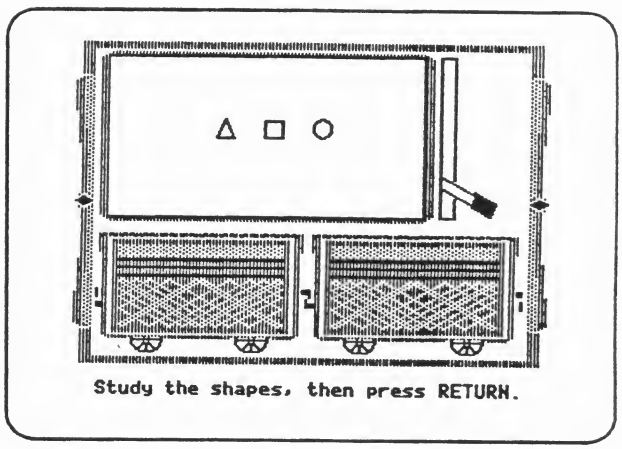


Shapes to Words

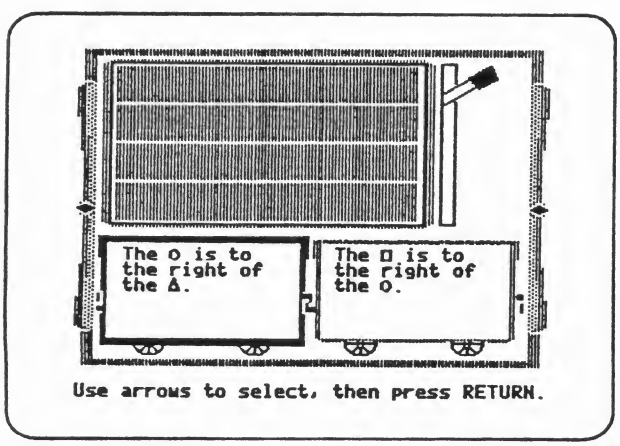
Shapes to Words begins with the students selecting from three levels of difficulty. Level 1 contains three shapes, Level 2 contains four shapes and Level 3 contains either three or four shapes, but includes more complex statements.



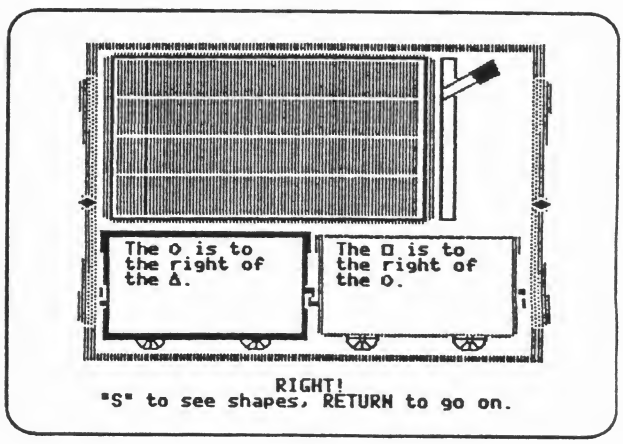
Next, students are shown a set of geometric shapes and asked to study them. (Students must study not only the shapes but also their positions in relation to one another.)



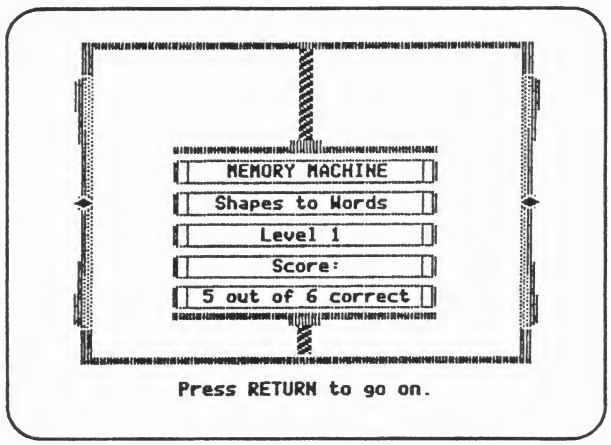
Students are then shown two statements and asked to select the one that describes the shapes.



Students are told if their answer is correct and given the option of seeing the shapes again before continuing.



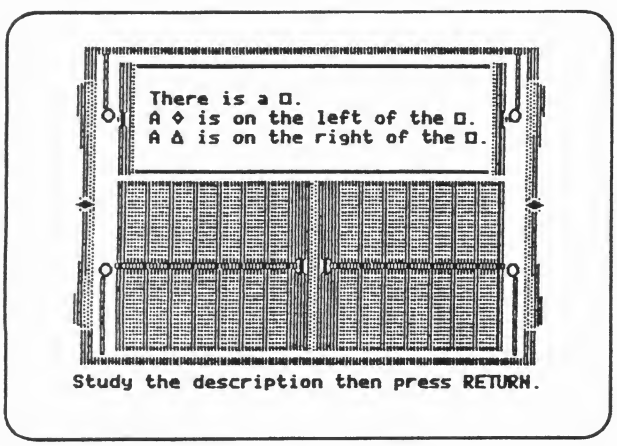
After a total of 3 sets of shapes, each with two sets of descriptive statements, a score screen is shown. Scores from the score screen can be recorded on the Student Record Sheet (page 27). The Memory Machine operates (whistles, etc.) if students have a perfect score.

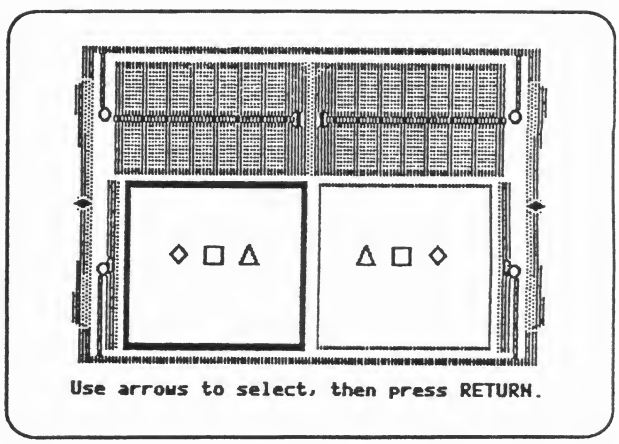


Words to Shapes

Words to Shapes has three levels of play. Play begins with the student studying statements that describe a set of geometric shapes. In the higher levels, more shapes are used and the statements are more complex.

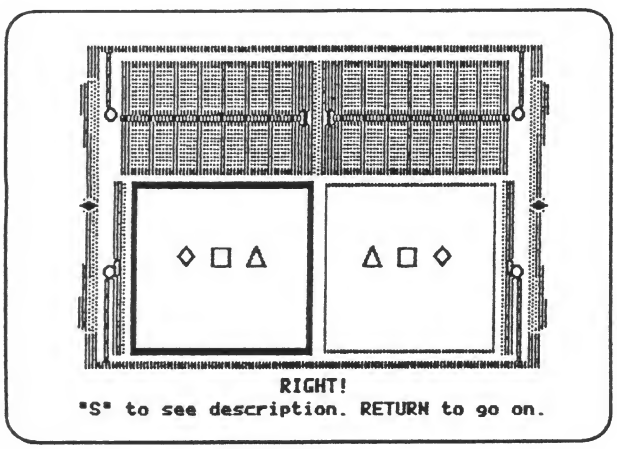
After studying the description, students are asked to select the correct set of shapes.

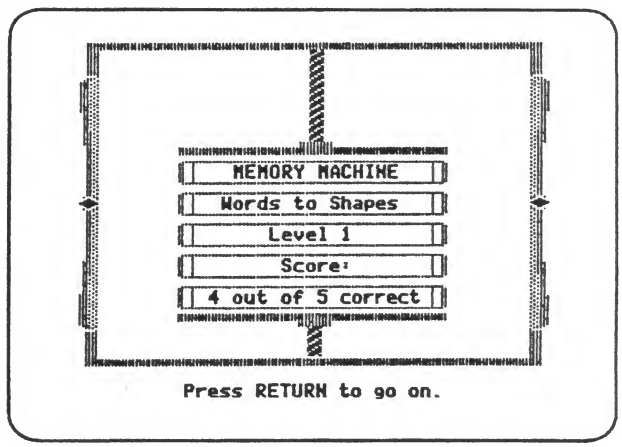




Students are told if their answer is correct and given the option of seeing the description again before continuing.

After selecting the shapes for 5 different descriptions, students are shown a score screen. Scores from the score screen can be recorded on the Student Record Sheet (page 27). The Memory Machine operates (whistles, etc.) when students have perfect scores.

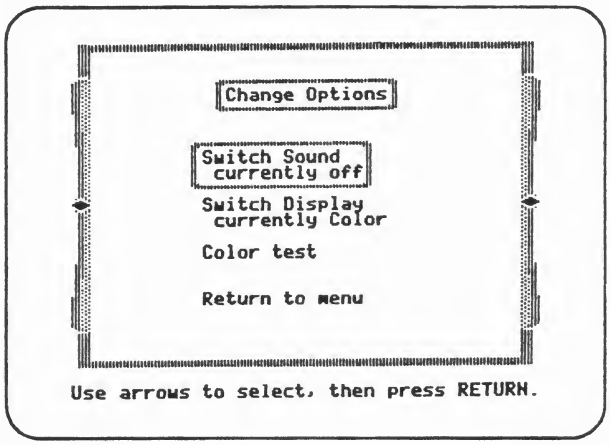




Note: You may exit the game and return to the main menu at any time by holding down the Control key while you press "E."

CHANGE OPTIONS

The *Change Options* menu is accessed by holding down the Control Key and typing "T" while the menu is being displayed.



Switch sound - You can turn the sound off or on.

Display - You can set the disk to be used with a color monitor or a monochrome (black-and-white or green screen) monitor. If you select a monochrome monitor, color-dependent descriptive statements will be eliminated. This affects only *Pictures to Words* and *Words to Pictures.*

Color test - You can use the color test samples to adjust the colors on your color monitor.

A NEWBERY ADVENTURE: A WRINKLE IN TIME

Table of Contents

Introduction..... 1

Background..... 2

Program Objectives..... 3

Program Description..... 4
- Charles' Vocabulary..... 4
  - Level One: Multiple choice..... 5
  - Level Two: Fill in the blank with hint..... 7
  - Level Three: Fill in the blank with no hint..... 8
  - Scoring..... 9
  - Vocabulary Answer List.....10
- Wrinkle Adventure.....11
  - Direct Adventure Path.....12
  - Top Twenty Scores.....13
  - Return to the Main Menu.....13
  - Exiting the Program.....13

Change Options.....14

Classroom Use.....17

Vocabulary List.....19

Vocabulary Worksheets and Answer Keys.....20

Adventure Worksheet and Answer Key.....24

Apple: Working with the Computer.....26

Apple IIS: Control Panel Settings.....27

Commodore 64: Working with the Computer.....28

"What Happens If...?" -- Sunburst Courseware and Warranty.....29

A NEWBERY ADVENTURE: A WRINKLE IN TIME

Background

A NEWBERY ADVENTURE: A WRINKLE IN TIME focuses on the imaginary events described in Madeleine L'Engle's Newbery Award-winning novel. It is an adventure story that could best be described as a mixture of a science fiction and mystery. The novel makes challenging demands on the imagination and offers readers the opportunity to identify with a wide range of emotions.

The story begins on a stormy night. Meg Murry, her younger brother Charles Wallace, and their mother meet in the kitchen for a snack. The family scene is upset by the arrival of an unusual stranger whom Charles calls Mrs. Whatsit. She asks the Murrys if she can rest for a moment because she "just got blown off course" by the storm. Mrs. Whatsit startles Mrs. Murry by assuring her that "there is such a thing as a tesseract." This process is a way of traveling through time and space, a wrinkle in time, which Mr. and Mrs. Murry were exploring before Mr. Murry mysteriously disappeared.

The program follows the Murrys as Meg, Charles Wallace, and their friend, Calvin, join with Mrs. Whatsit and her two colleagues, Mrs. Who and Mrs. Which, to search for Mr. Murry. When they tesser to another planet, Uriel, Mrs. Whatsit metamorphoses into a horse-like winged creature and takes them to the summit of a mountain where they learn about the evil force which has captured their father and which threatens the Earth.

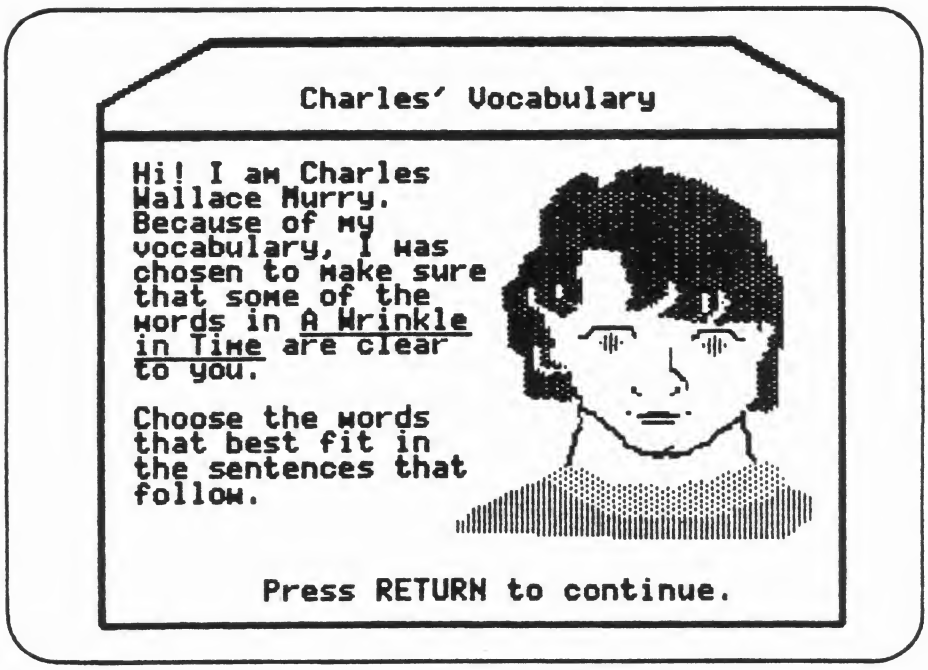
After an unfortunate stop at a two-dimensional planet, the voyagers visit the planet of the Happy Medium and learn that they must travel to Camazotz, a planet controlled by the dark powers, if they are to rescue Mr. Murry. When they arrive in Camazotz, Meg, Charles, and Calvin learn that the ruler of this planet, IT, has replaced individuality with total conformity. They also learn that Mr. Murry is IT's prisoner. When they encounter IT's representative, the Man with the Red Eyes, Charles Wallace is hynotized and submits to IT.

The suspense is sustained at a high level as Meg must use her special glasses, a gift from Mrs. Who, to release her father from IT, but Mr. Murry is forced to tesser away from Camazotz with Meg and Calvin before they all give in to IT.

During this trip, Meg almost dies, but she is saved by Aunt Beast, a tentacled creature on the planet where they land. When she is well, Meg realizes that she must return to Camazotz to save her brother Charles Wallace from IT. The point of the story is made when Meg realizes that her strength against IT is her love for Charles Wallace. The adventure ends as Meg, Charles Wallace, Calvin, and Mr. Murry return safely home.

A NEWBERY ADVENTURE: A WRINKLE IN TIME

Program Objectives


Charles' Vocabulary
Hi! I am Charles Wallace Murry. Because of my vocabulary, I was chosen to make sure that some of the words in A Wrinkle in Time are clear to you.
Choose the words that best fit in the sentences that follow.
Press RETURN to continue.

Grade Level: 4 - 8

Reading Level: Grade 5-6 (Dale Chall)

Time required: Vocabulary - 5-15 minutes
Adventure - 10-30 minutes

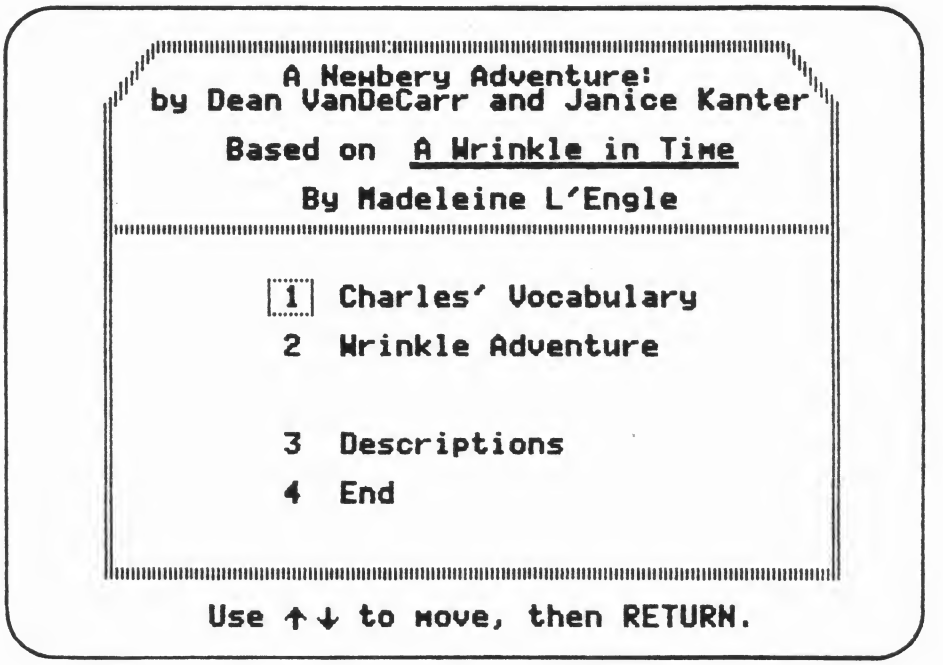
Objectives:

1. To build and reinforce vocabulary and comprehension skills.
2. To provide practice in using vocabulary in context.
3. To develop the ability to use content clues in reading.
4. To develop the ability to follow a sequence of event.
5. To combine exposure to good literature with the practice of vocabulary and comprehension skills.
6. To encourage the thoughtful reading of novels.
7. To transform reading into a pleasurable experience for the non-motivated reader.

A NEWBERY ADVENTURE: A WRINKLE IN TIME

Program Description

Following the opening screen, a main menu is displayed. For a brief introduction to the program, students select Descriptions, or they may choose the other options as shown on the menu below:



CHARLES' VOCABULARY

In this option, students become familiar with some vocabulary words as they are used in the book A Wrinkle in Time. Students are presented with ten statements relating to the story. These statements will vary each time the option is used. Each of these statements contain a blank space that must be filled with a word taken from the Vocabulary List of primary words (page 10), and students must type in the correct word.

Through the Change Options (page 14), teachers can set the activity to one of three levels of difficulty:

- Level One: Multiple choice
- Level Two: Fill in the blank with hint
- Level Three: Fill in the blank with no hint

A NEWBERY ADVENTURE: A WRINKLE IN TIME

Level One: Multiple choice - students are given a choice of three words. One of these words is the correct one as in the following example:

Our journey begins after we meet Calvin at the haunted house. The ladies use a ---------, a way of traveling through time and space, to take us to Uriel.
I was thinking of one of the words below.
tesseract privilege whirlwind

Students must type in the correct word. A successful answer will result in a short message acknowledging that the word entered is correct, and students can move on to the next statement. If the word entered is incorrect, students are given a second try as shown below:

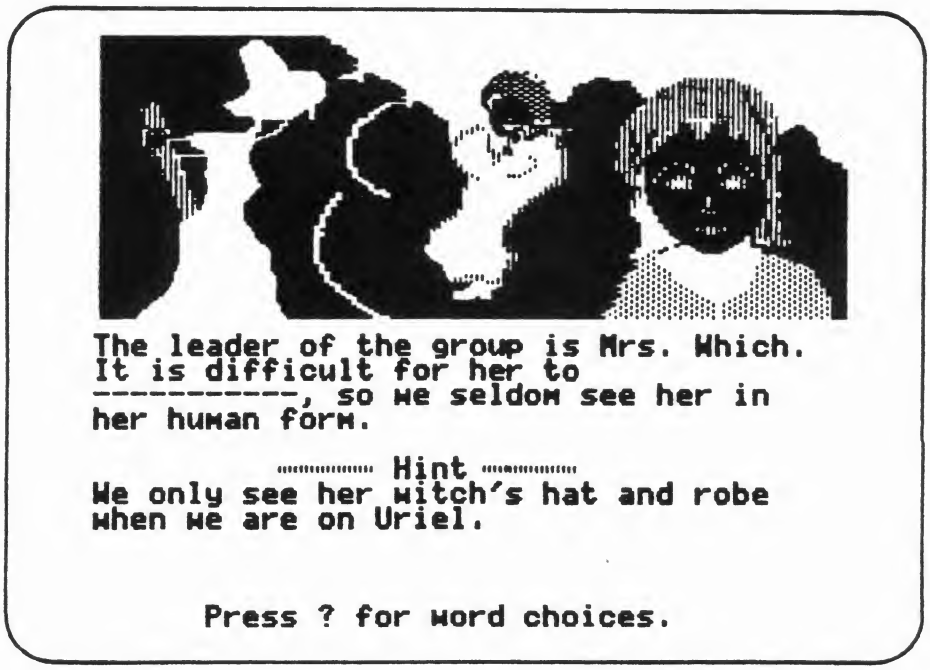
Our journey begins after we meet Calvin at the haunted house. The ladies use a whirlwind, a way of traveling through time and space, to take us to Uriel.
That is not the word I had in mind.
Press RETURN to try again.

If the word entered is still incorrect, the answer is displayed as in the following example:

Our journey begins after we meet Calvin at the haunted house. The ladies use a privilege, a way of traveling through time and space, to take us to Uriel.
No, the word I was thinking of is tesseract.
Press RETURN to continue.

The correct answer is then placed in the sentence and the students can move on to the next statement.

Level Two: Fill in the blank with hint - students are given a hint, and they must type in the correct word as shown below:


The leader of the group is Mrs. Which.
It is difficult for her to
----------, so we seldom see her in
her human form.
Hint
We only see her witch's hat and robe
when we are on Uriel.
Press ? for word choices.

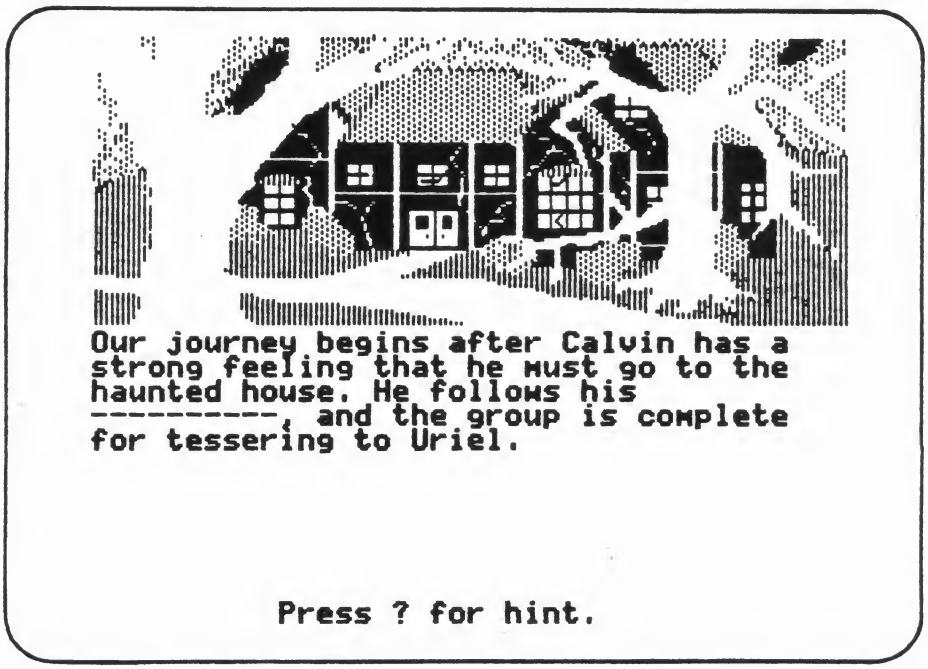
Students can proceed with the activity as follows:

- by requesting a word choice. Students can press the ? key to get a choice of three words. If the choice they enter is incorrect, the answer is displayed, and students can move on to the next statement.

- by not requesting a word choice. In this case, students are allowed two tries.
  - First Try: students enter their answer without pressing the ? key. If the word entered is incorrect, they are given a second try.
  - Second Try: students are given a choice of three words. If the choice they enter is incorrect, the answer is displayed, and students can move on to the next statement.

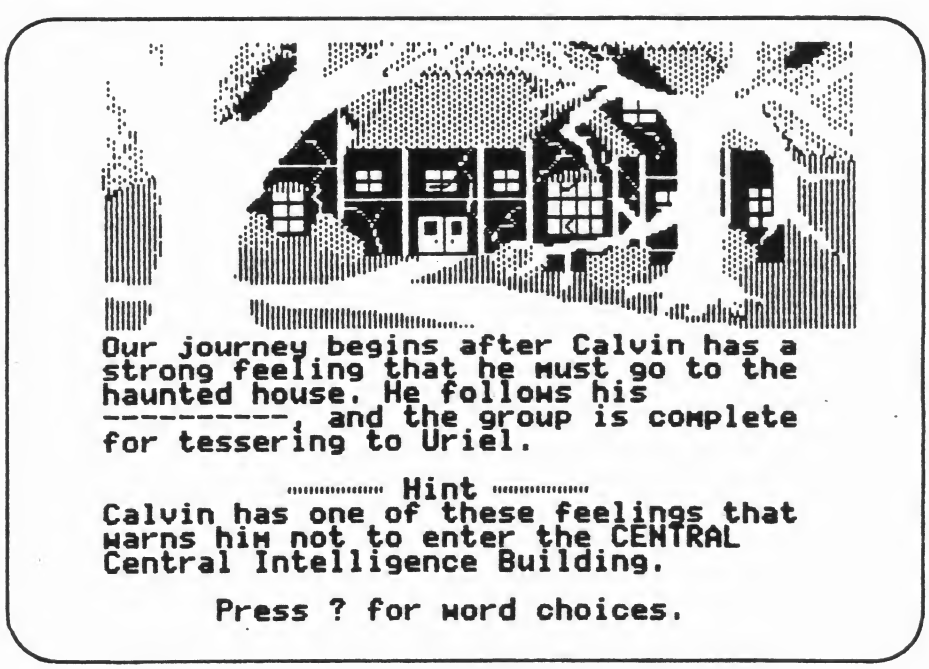
Note: Whether students used one or two tries to reach the correct answer has no bearing on the scoring.

Level Three: Fill in the blank with no hint - the students are asked to complete a statement by typing in the correct word as shown below:


Our journey begins after Calvin has a strong feeling that he must go to the haunted house. He follows his ----------, and the group is complete for tessering to Uriel.
Press ? for hint.

Two types of help are available by pressing the ? key:

- the first time it is pressed, a hint appears
- the second time it is pressed, 3 possible word choices appear.

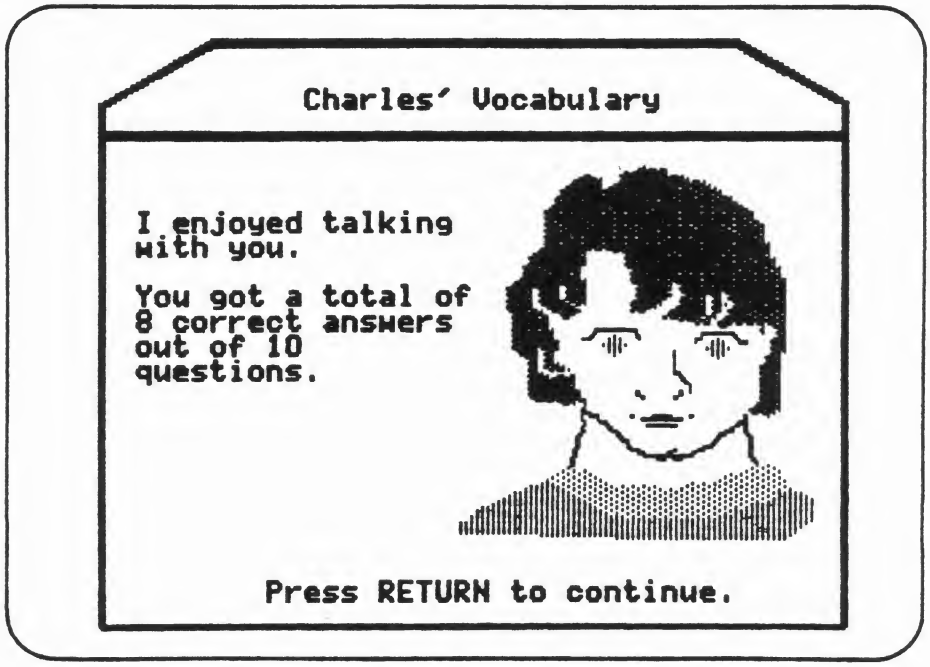

Our journey begins after Calvin has a strong feeling that he must go to the haunted house. He follows his ----------, and the group is complete for tessering to Uriel.
Hint
Calvin has one of these feelings that warns him not to enter the CENTRAL Central Intelligence Building.
Press ? for word choices.

After each help, students are requested to type in the correct word. Students are also given the hint on their first incorrect try and the 3 possible word choices on the second incorrect try. If the word they enter after seeing the three choices is incorrect, they are then shown the correct answer and move on to the next question.

Scoring

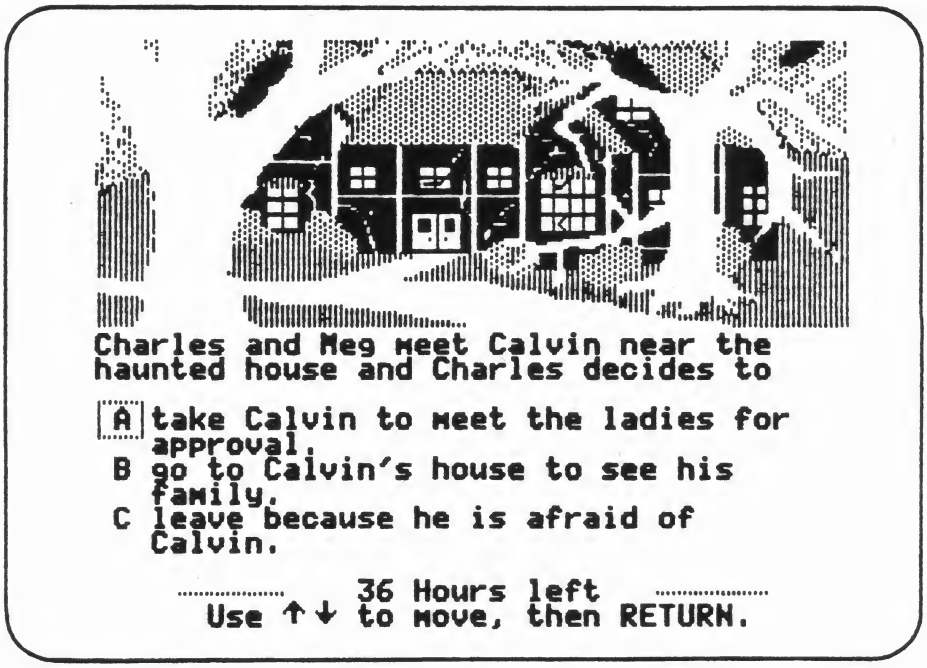
After all the statements have been completed, each student is given the number of correct answers as shown below:

Note: Whether students used one, two, or three tries to reach the correct answer has no bearing on the scoring.


Charles' Vocabulary
I enjoyed talking with you.
You got a total of 8 correct answers out of 10 questions.
Press RETURN to continue.

WRINKLE ADVENTURE

This option encourages students to use their knowledge of the book to make decisions that will help Meg, Calvin, and Charles to rescue Mr. Murry. The decisions the students make relate to possible moves that the protagonists of the story could make, as in the following example:


Charles and Meg meet Calvin near the haunted house and Charles decides to
A take Calvin to meet the ladies for approval.
B go to Calvin's house to see his family.
C leave because he is afraid of Calvin.
36 Hours left
Use ↑↓ to move, then RETURN.

At the start of the Wrinkle Adventure, the students are given thirty-six hours to complete their quest. This time limit is called a time wrinkle. Each move made by the characters costs a student two hours taken from the time wrinkle. Consequently, students must weigh their decisions very carefully.

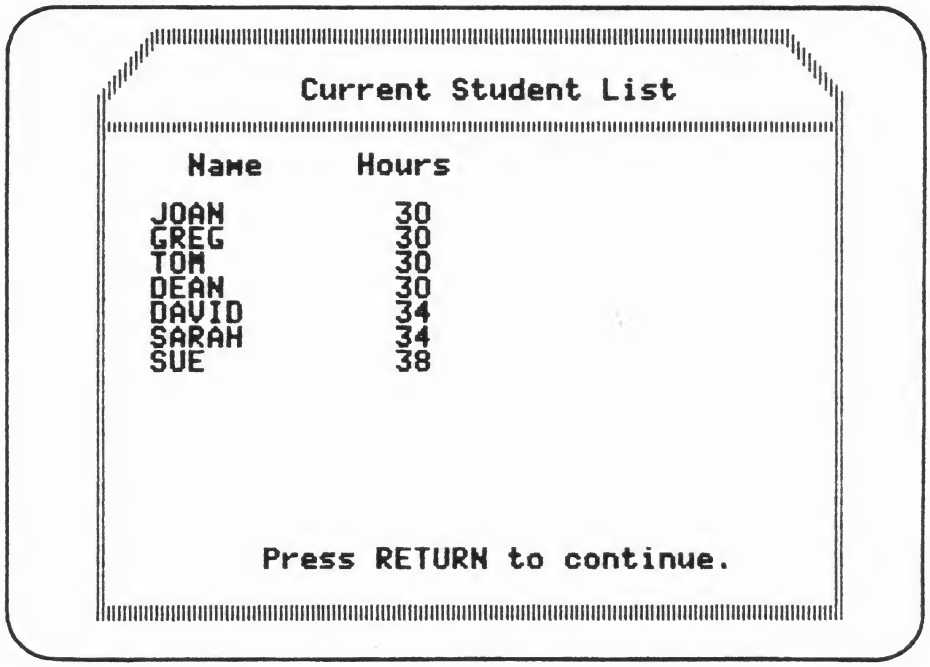
The time wrinkle may be changed by the teacher through the Change Option (page 14). The best possible completion time is thirty hours. Depending on the time wrinkle given to them, students may or may not have enough time to wander in the wrong direction before getting back on the right path and completing the Wrinkle Adventure.

As students may not be able to complete the Wrinkle Adventure on their first try, they should be encouraged to take notes while playing the game. This will allow them to chart their progress and try a different approach on subsequent tries.

Top Twenty Scores

At the end of the game, the number of hours it took each student to complete the Wrinkle Adventure is displayed. The names of the students with the top twenty scores are saved on the diskette.

Everytime a new record is broken, the new winner's name is inserted at the appropriate place among the other students' names. If twenty names are on the diskette, the last name on the list is then automatically deleted. This list appears as shown below:



Return to the main menu

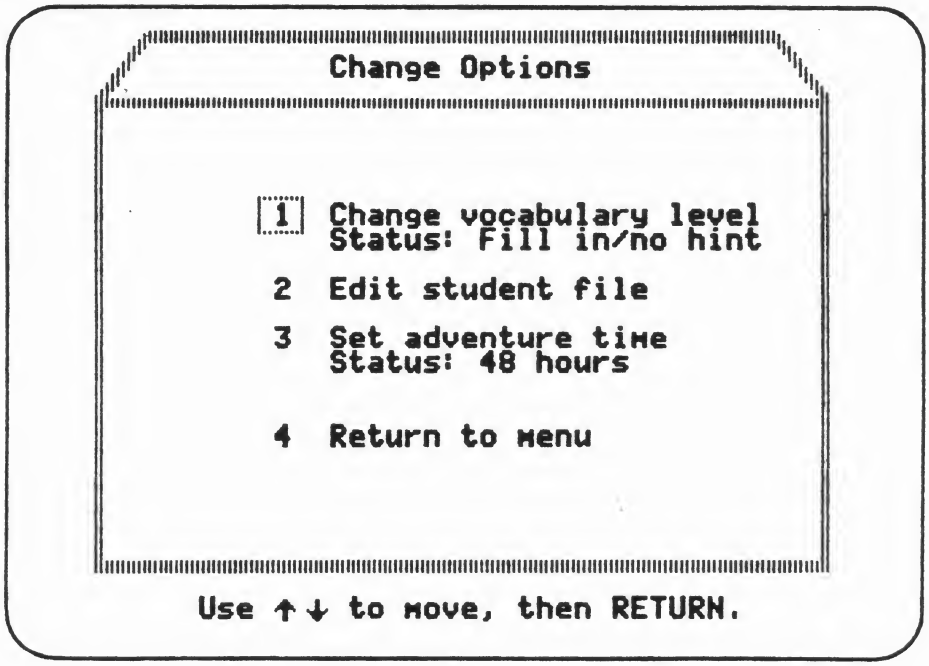
This option allows students to return to the main menu and select a different option or end the game.

Exiting the program

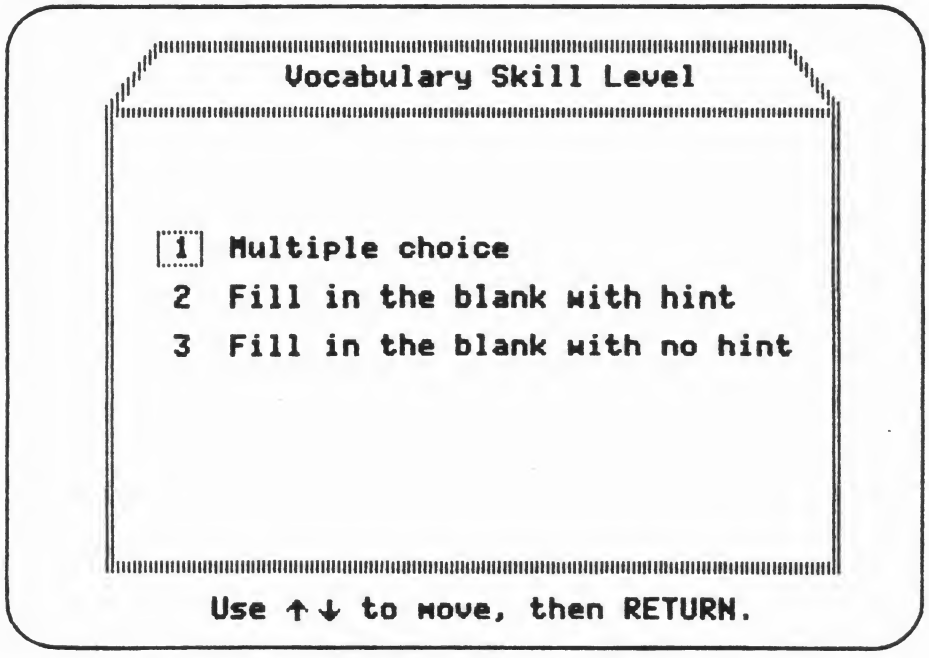
Students may stop the game at any time by holding down the CONTROL (CTRL) key and pressing the E key. They will then be able to go back to the main menu, use another diskette, or end the session at the computer.

Change Options

The Change Options allow you to control certain elements of the Wrinkle Adventure in order to adapt to the needs of the students. To use the Change Options, hold down the CONTROL (CTRL) key and press T at the main menu. The Change Options menu will then be displayed, as shown below:

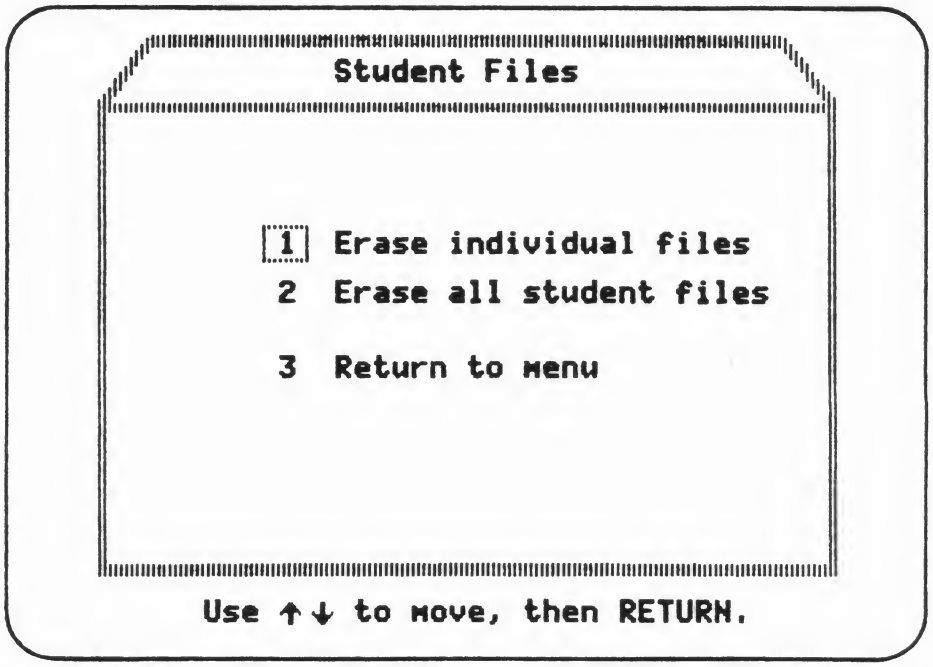


Change vocabulary level - allows you to change the difficulty level of Charles' Vocabulary, as shown below:

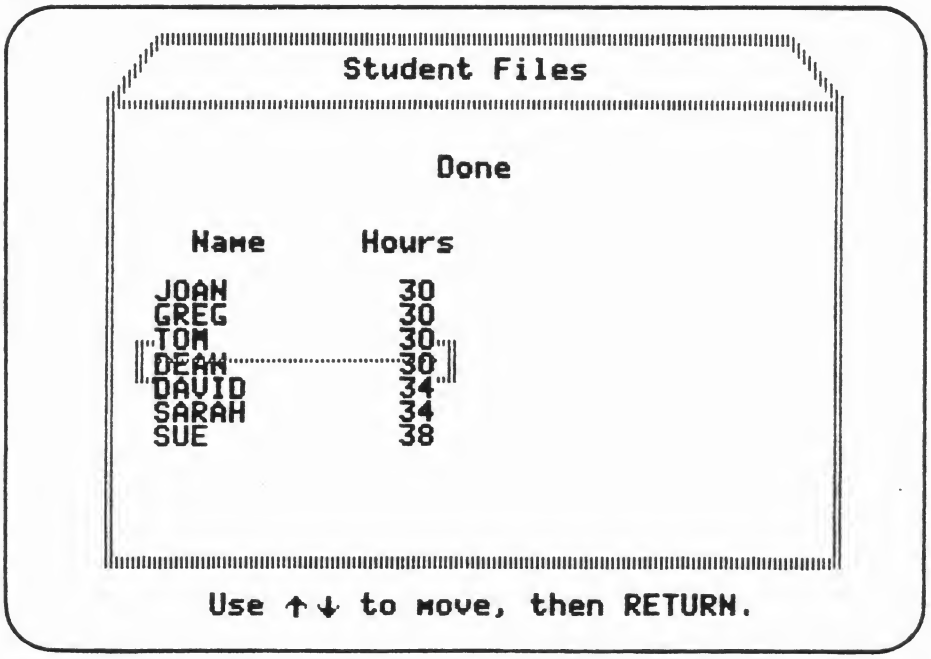

Vocabulary Skill Level
1 Multiple choice
2 Fill in the blank with hint
3 Fill in the blank with no hint
Use ↑↓ to move, then RETURN.

Once the level has been changed, it will remain as set every time the program is used, until this option is used again.

Edit Student File - allows you to delete the names and the corresponding scores of the students with the twenty top scores as follows:

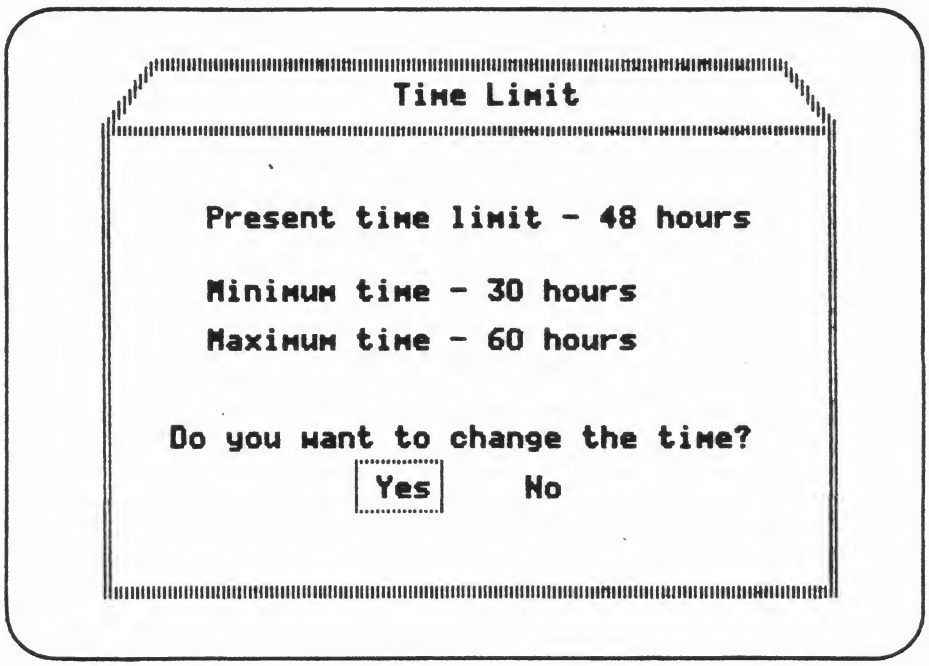


When choosing Erase individual files, you will be shown the names with the top twenty scores. You can then select the name and score to be deleted, as in the following example:



When the names and scores to be deleted are selected, moving the box to DONE will delete them and return to the menu. When choosing Erase all student files, you will be given the option to cancel the procedure before all the names and scores are deleted.

Set adventure time - allows you to control the time wrinkle. This time wrinkle can be set at a minimum of thirty hours and a maximum of sixty hours, as shown below:



Return to Menu - allows you to return to the main menu.

TABLE OF CONTENTS

The Pond: Strategies in Problem Solving

Introduction..... 1

Problem Solving Matrix..... 3

Overview/Objectives..... 4

Program Description..... 5
The Practice..... 5
The Game..... 11

Classroom Use..... 12

THE POND Recording Sheet-Apple..... 14

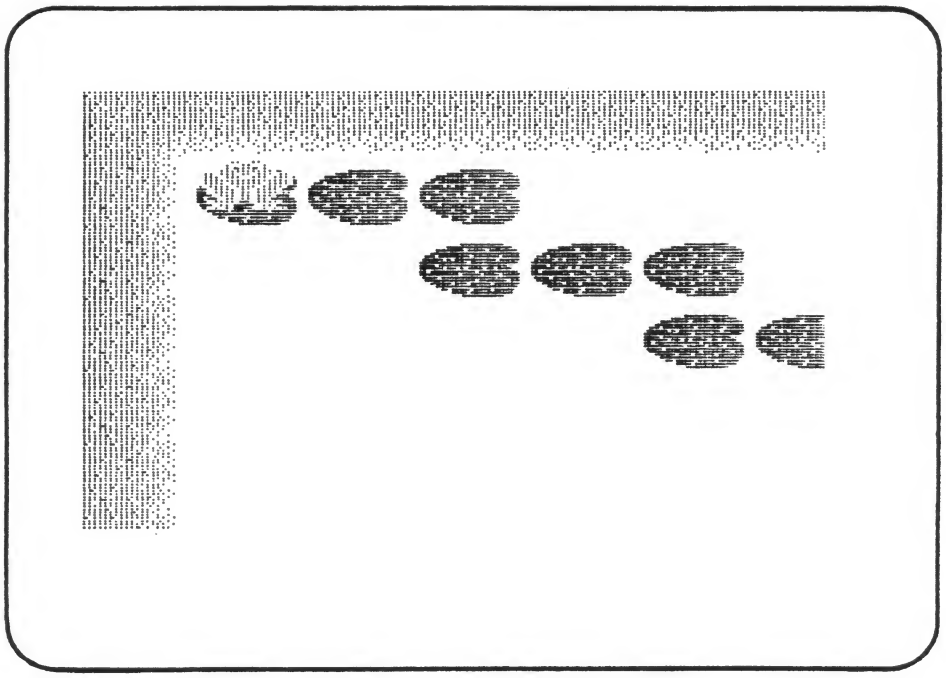
THE POND Recording Sheet-Commodore..... 15

Apple II: Working With Your Computer..... 16

Commodore: Working With Your Computer..... 17

"What Happens If...?" Sunburst Courseware and Warranty..... 18

THE POND: Strategies in Problem Solving



Skills: pattern recognition, prediction, logic

Student Work With: directions -- up, down, left, right
sequence

Grade Level: 2-adult

Reading Level: 2nd grade (Fry)

Time Required: 10-40 minutes

Objectives:

1. to find order and discover patterns, improve perception.
2. to gain experience in understanding the importance of sequence.
3. to learn to use the experimentation process to formulate a hypothesis.
4. to recognize that there may be more than one solution (pattern) to a problem.

THE POND

Program Description

The objective of the program is for the student to help a frog jump along a maze of lily pads arranged in a pattern. Students can discover the pattern by moving the frog one lily pad at a time. However, in order to reach the magic lily pad at the end of the pattern, the student must be able to identify and type in a pattern that will make the frog jump through the pond without falling into the water. The pattern entered must repeat at least once for the frog to jump onto the magic lily pad.

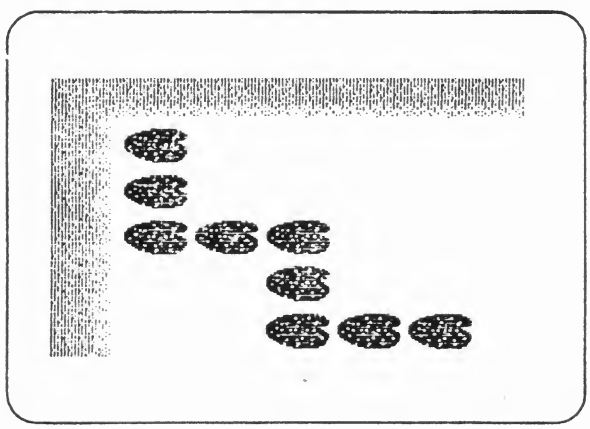
At the beginning of the program, the students have two options: (1) to practice or (2) to play the game.

The options for instructions and ending are also listed.

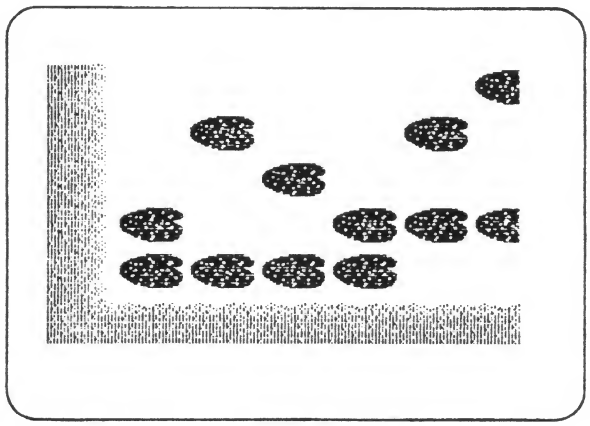
The Practice

The practice option allows the student to choose any of six ponds. Each successive pond is a higher difficulty level.

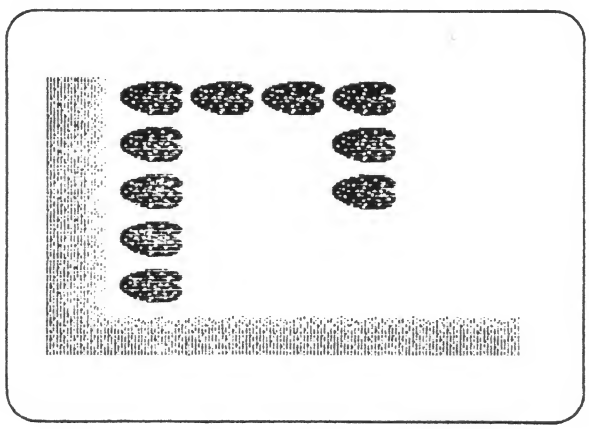
Level 1 - Farmer Jane's Ponds two-step patterns.



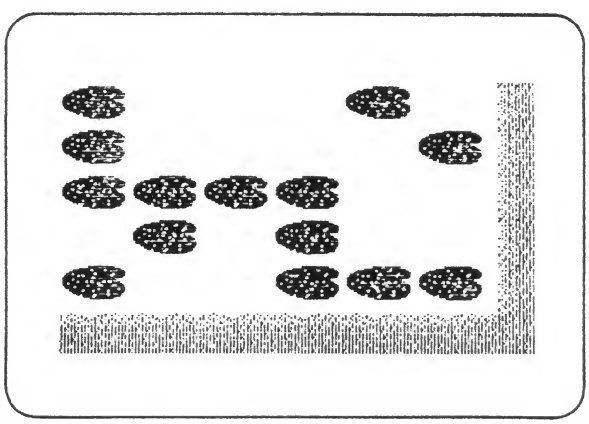
Level 2 - Billy Bob's Ponds — two-step patterns with distractors (extra lily pads in the pond make it harder to identify the pattern.)



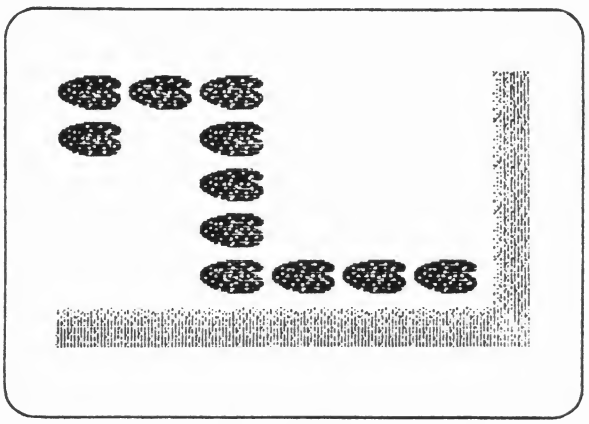
Level 3 - The Puzzle Ponds — three-step patterns.



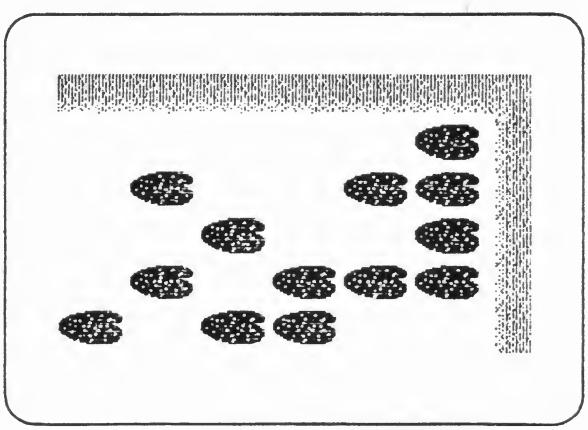
Level 4 - The Lost Ponds — three-step patterns with distractors.



Level 5 - The Maze Ponds four-step patterns.



Level 6 - The Twister Ponds four-step patterns with distractors.



The students choose the level they want to practice. In the first problem of each level, the frog starts in the upper left hand corner. After that the frog may appear in any corner.

The students can move the frog within the pond using the arrow keys (↑ ↓ ← or →.) On the Apple II you can use the I key to go ↑ , the K key to go →, the J to go ← and the M key to go ↓ .

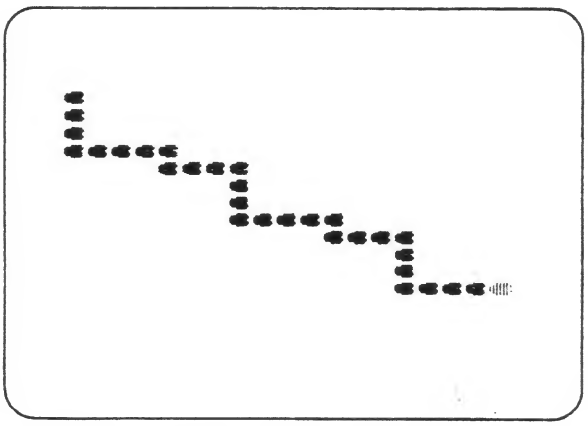
The following keys also work on Apple:

```
    A
← + →
    Z
```

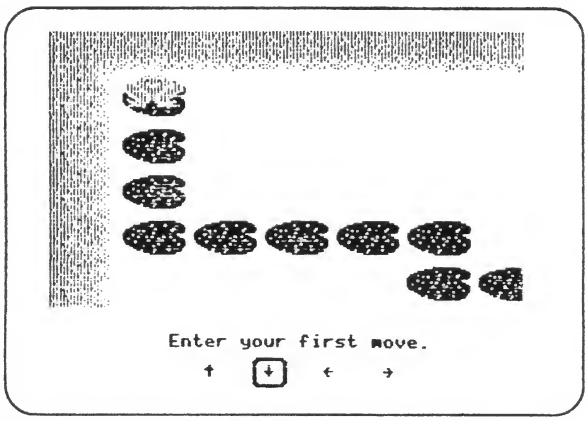
If they direct the frog off a lily pad, it splashes into the water, then climbs back onto the pad. A magic lily pad will be at the end of the pattern. The students can get the frog to jump onto the magic lily pad by discovering the pattern. They cannot jump the frog onto the magic pad, or onto the grass surrounding the pond, by using the arrow keys.

If students need help, there are two levels of help available. On the Apple, the 9 key will illuminate the pattern on the screen. On the Commodore, the f3 key will illuminate the pattern. These keys are useful only in levels 2, 4, and 6 where the distractors may make the pattern hard to find.

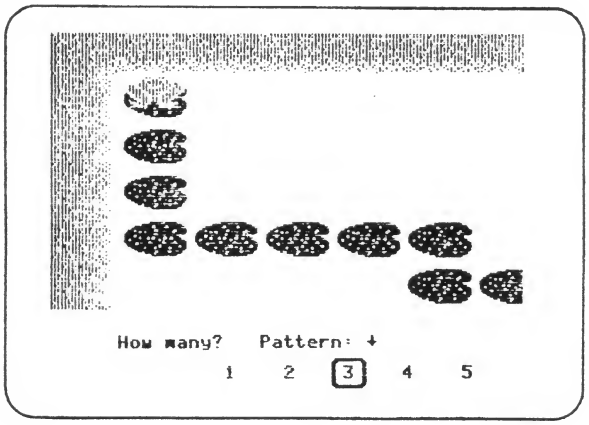
The second level of help, as shown below, will display the entire pond. This done with the Ø key on the Apple and the f1 key on the Commodore.



Once students know the pattern, they press the RETURN key. They then must select the direction and the number of moves. For example, if the frog started in the upper left and the pattern was down three, over four, down one, over three, (see the picture below), the students would move the box, using the greater than and less than key (> or <), to the ↓ and press the RETURN.



The computer will next ask how many moves. In the example, down 3, the students would move the box, to the 3 and press RETURN. The maximum number of moves is 5.



The students enter the entire pattern before executing it. The process is repeated to enter the rest of the pattern. If students make a mistake, ERASE will remove the last step of the pattern. For example, if the pattern were ↓ 2 → 3 ↓ 2, and the student selected ERASE, the pattern would become ↓ 2 → 3.

Once the complete pattern is entered, the student will move the box to GO! and press RETURN. With another RETURN key, the frog will execute the pattern. If the pattern is incorrect and the frog jumps off the lily pad, it will land in the water and swim back to the starting lily pad. If the frog tries to leave the pond by jumping on the grass, the pattern stops and the student is asked to try again. If the pattern does not repeat (complete one whole sequence and start over), the frog will not be able to jump on the magic lily pad.

If the pattern is correct, the frog will jump onto the magic lily pad at the end of the pond and a sound and a wink will signify the frog has successfully completed the pattern.

After the frog has successfully or unsuccessfully executed the pattern, students are asked if they want the same problem again. If they select NO, they are asked if they would like to try another pond in the same level. If they again select NO, they will go back to the menu and may choose a different level.

Holding the CTRL button and pressing the E key will end the activity at any point and send students back to the menu.

Special Instructions on the Apple

On the Apple, you can control the sound and the background. The teacher may access the sound control option by holding the Control key and pressing the "T" key at the menu when the program is first started. (This will not work after you have played the game. You must turn the Apple off and start over.) The sound can then be activated or turned off. If the teacher leaves the sound on, the student may turn it off or on with a Control S during the program. If the teacher turns it off, the Control S will not work.

A Control B (background) will change the color of the background. The Pond will appear more colorful on a television or color monitor. This option is not recommended on a green screen monitor.

THE ROYAL RULES

Table of Contents

Introduction..... 1

Program Objectives..... 4

Program Overview..... 5

Program Description..... 6
- Starting the Program..... 6
- Testing Hypotheses..... 7
- Player Options..... 8
  - Help..... 8
  - Recap..... 8
  - Quiz Request..... 8
- Exiting the Program.....10

Difficulty Levels.....11
- Rule Display.....11
- Level 1: The City.....12
- Level 2: The Duchy.....13
- Level 3: The Province.....14
- Level 4: The Kingdom.....16

Creating Rules.....19
- Level 1.....19
- Level 2.....21
- Level 3 & 4.....23

Change Options.....27
- Sound Option.....27
- Rule Option.....27
- View Rules.....28
- Delete Player Rules.....29
- Create Player Rules.....29
- Prepare or Copy a Data Disk.....30
- Return to Main Menu.....30

Classroom Use.....31

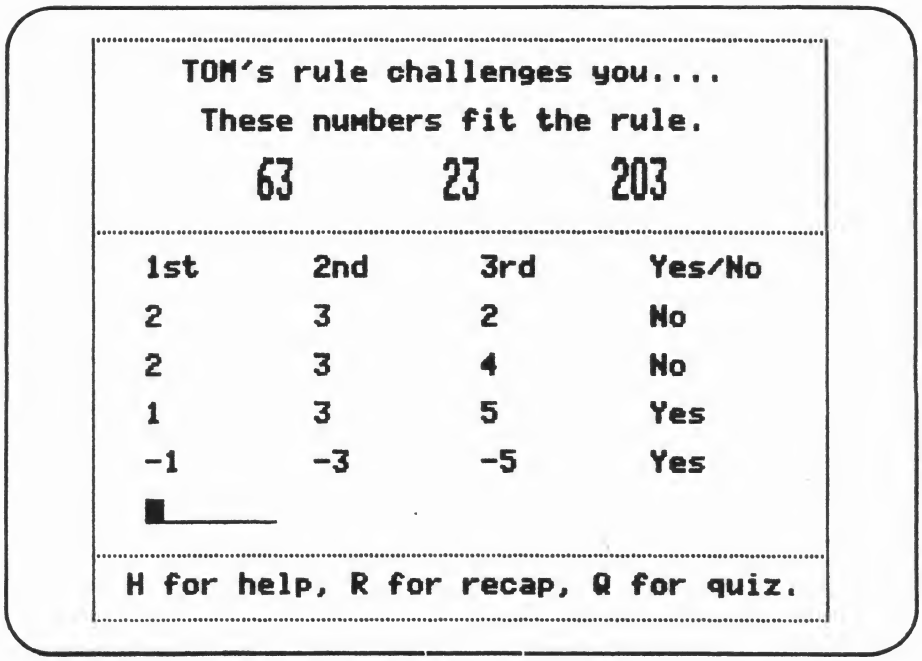
Observations from Field Testing.....32

Apple: Working with the Computer.....33

What Happens If...? -- Sunburst Courseware and Warranty.....34

THE ROYAL RULES

Program Objectives


TOM's rule challenges you....
These numbers fit the rule.
63 23 203
1st 2nd 3rd Yes/No
2 3 2 No
2 3 4 No
1 3 5 Yes
-1 -3 -5 Yes
H for help, R for recap, Q for quiz.

Skills: Recognizing number patterns and relationships
Adding, subtracting, multiplying, and dividing
Forming and testing hypotheses
Problem solving
Developing and using complex classification strategies

Grade Level: 6 - adult

Reading Level: 4th grade (Fry)

Time Required: 10-20 minutes for each level

Objectives:
1. To enable players to form and test hypotheses.
2. To help players build skills in recognizing numerical patterns and relationships.
3. To help players develop skills in critical thinking and problem solving.

THE ROYAL RULES

Program Overview

The Royal Rules includes a Program Diskette and a Data Diskette. On the Program Diskette, players solve number problems--guessing the rules that apply to sets of three numbers--at four levels of difficulty. After they have discovered three rules on a chosen level, players are allowed to solve new rules or to enter rules of their own which are then saved onto the Data Diskette. The ultimate objective for players is to come face-to-face with the Queen, at which time each player is challenged to solve a final series of problems. To finish the game at this level may require many tries, even for a very able player.

The program has four levels of difficulty:

Level 1: The City
Level 2: The Duchy
Level 3: The Province
Level 4: The Kingdom

At each level, players can choose to play against the Sunburst Rules provided on the Program Diskette, the Player Rules entered on the Data Diskette by previous players, or a combination of both.

On each level, players are shown three numbers that correspond to a secret rule. They must generate their own hypotheses about the rule, and then test those hypotheses by entering their own sets of three numbers to be checked against the rule. Players will receive a "Yes" answer to those sets that conform to the rule, and a "No" answer to those that do not. When players feel confident that they know the rule, they can take a quiz that tests their hypothesis.

If players fail a quiz by answering any of its questions incorrectly, they may try the same rule again. They can also choose a new rule. But they cannot enter a rule of their own for others to play against until they have passed three quizzes on one level.

Starting the Program

Students start with the Program Diskette and choose a level from the main menu, as shown below:

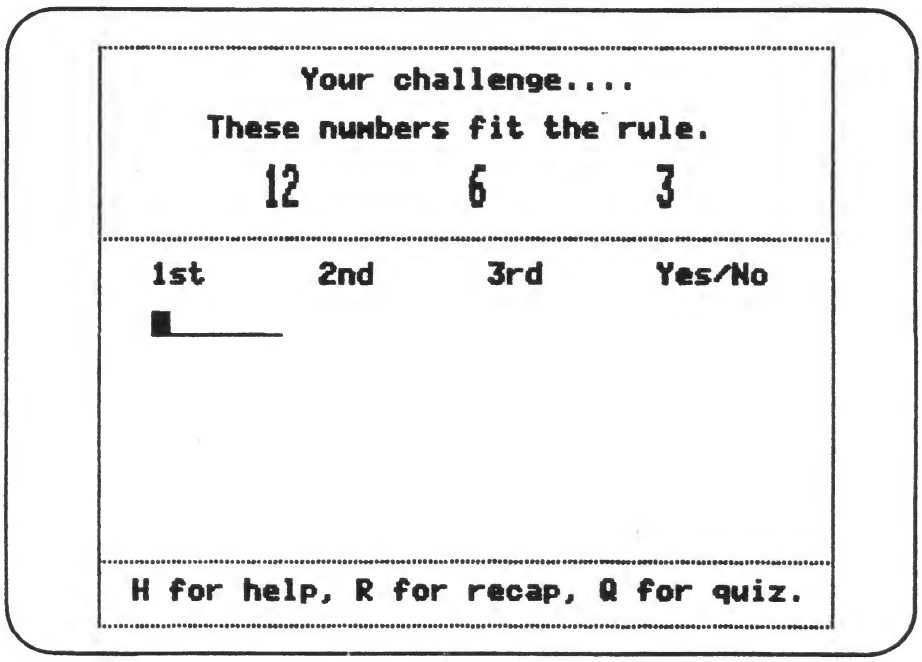
On each level, players can choose Sunburst Rules, Player Rules, or Combination of Both, as shown below:

THE ROYAL RULES
Designed by Tom O'Brien
Programmed by Raoul Watson
Which do you want to play with?
Sunburst Rules
Player Rules
Combination of Both
Use the ↑↓ keys, then press RETURN.

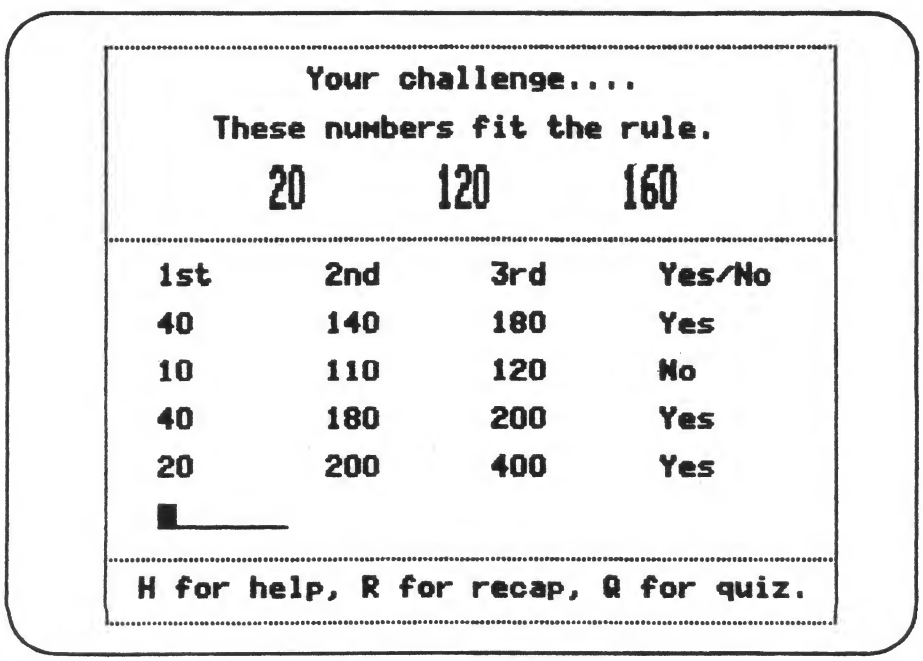
Players who select Player Rules or Combination of Both will need the Data Diskette. If the Data Diskette is empty (as when it is used for the first time), players will be informed that there are no Player Rules available.

Testing Hypotheses

On each level, players are shown three numbers corresponding to a secret rule, as in the following example:



Players must then generate their own hypotheses by entering their own sets of three numbers to be checked against the rule. They will receive a "Yes" answer to those sets that conform to the rule, and a "No" answer to those that do not, as in the following example:


Your challenge....
These numbers fit the rule.
20 120 160
1st 2nd 3rd Yes/No
40 140 180 Yes
10 110 120 No
40 180 200 Yes
20 200 400 Yes
H for help, R for recap, Q for quiz.

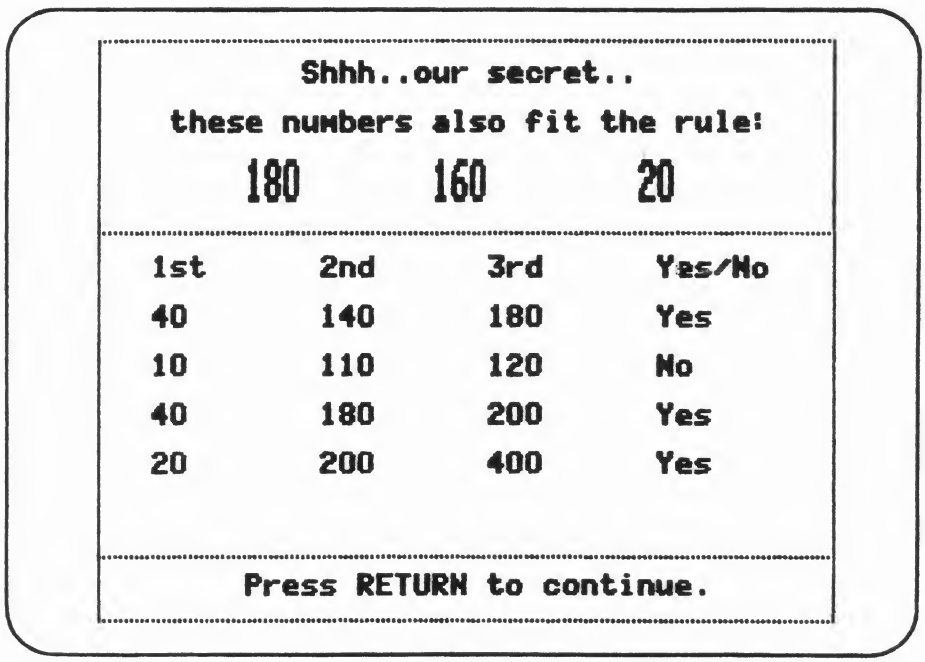
The goal is for players to test as many hypotheses as possible until they feel they know the rule and are ready to take a quiz.

Players can enter as many hypotheses as they wish. When they have filled the entire screen with their guesses, the first line is automatically deleted but not lost (see Recap below), allowing more entries at the bottom of the screen.

Player Options

At any time while testing their hypotheses, students can use the following options:

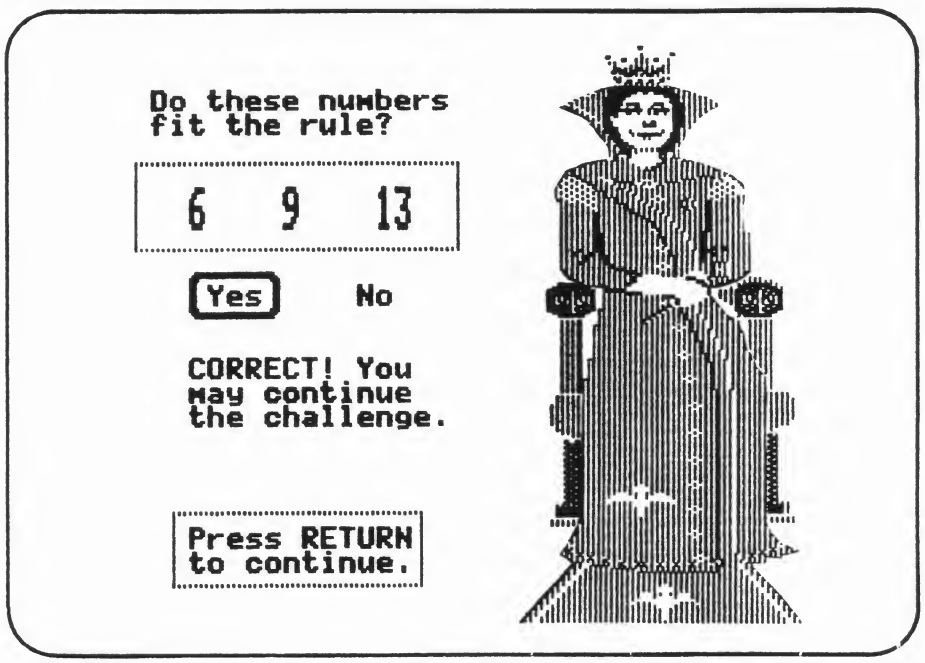
- Help - Players may press the H key to receive a new set of three numbers which also fit the rule, as in the following example:



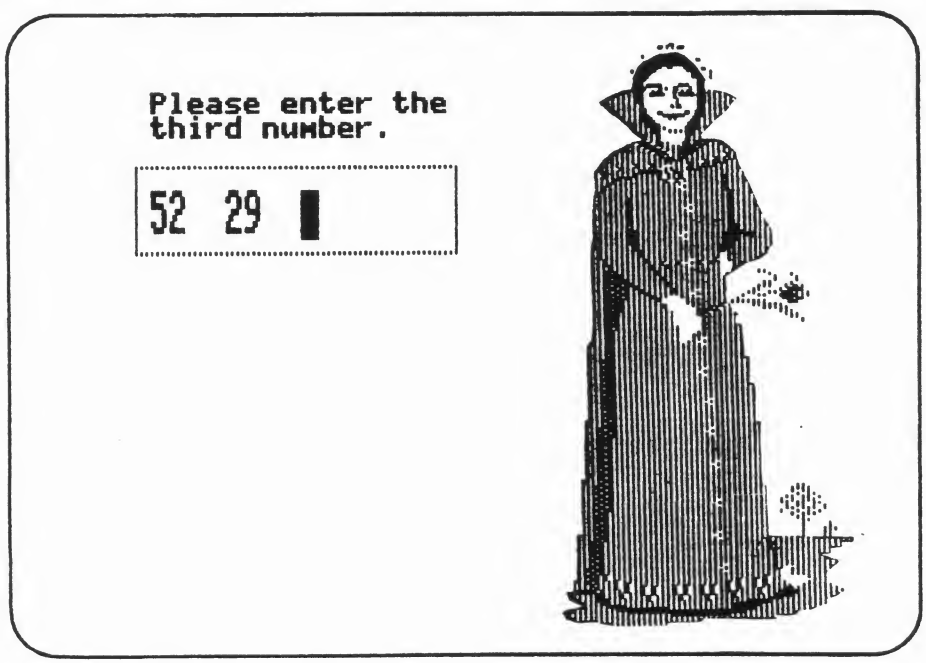
- Recap - Players who have entered more hypotheses than can fit on one screen may receive a recap of their previous guesses by pressing the R key at any number input.

- Quiz Request - Players can call for a quiz by pressing the Q key at any input during the hypothesis-testing activity. They will then be asked to answer five questions that will vary depending on the chosen level.

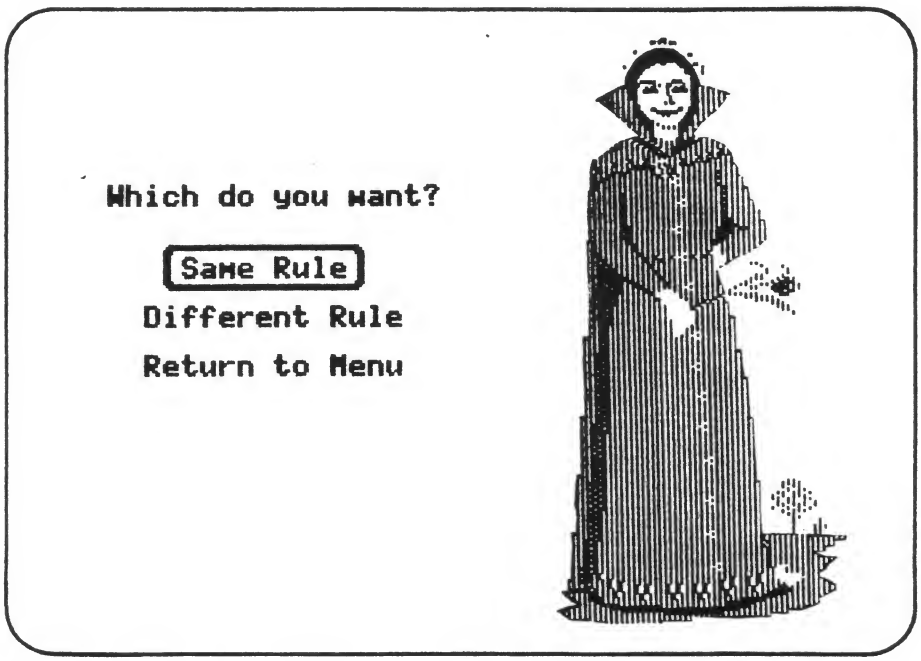
On levels 1 (The City), 3 (The Province), and 4 (The Kingdom), players are presented with five sets of three numbers, and they must state whether or not each set fits the rule, as in the following example:



On level 2 (The Duchy), players taking the quiz are given two numbers, they must supply a third number which will fit the rule, as shown below:



To complete a quiz successfully, players must answer each of the five questions correctly. Students who fail the quiz are given the following options:



Players who have passed the quiz are awarded an object which varies according to the chosen level. The objects displayed are the following:

Level 1: The City -- Magic Book
Level 2: The Duchy -- Royal Crest
Level 3: The Province -- Goblet
Level 4: The Kingdom -- Crown

Players who have passed three quizzes at any level are given the choice to enter their own rules (see Creating Rules page 19) provided the teacher has permitted this option (see Change Options page 27). Players who do not wish to enter their own rules are returned to the main menu. They can then select a different level and play the game again.

Exiting the Program

Players can exit the program at any time by holding down the CONTROL (CTRL) key and pressing the E key. If they choose to exit the game during the hypothesis-testing or the quiz activities of the program, they will be given the option to choose the same rules, to choose a different rule, or to return to the main menu.

Please Note: Students who have won one quiz and return to the main menu before completing the next two quizzes will lose that first quiz object.

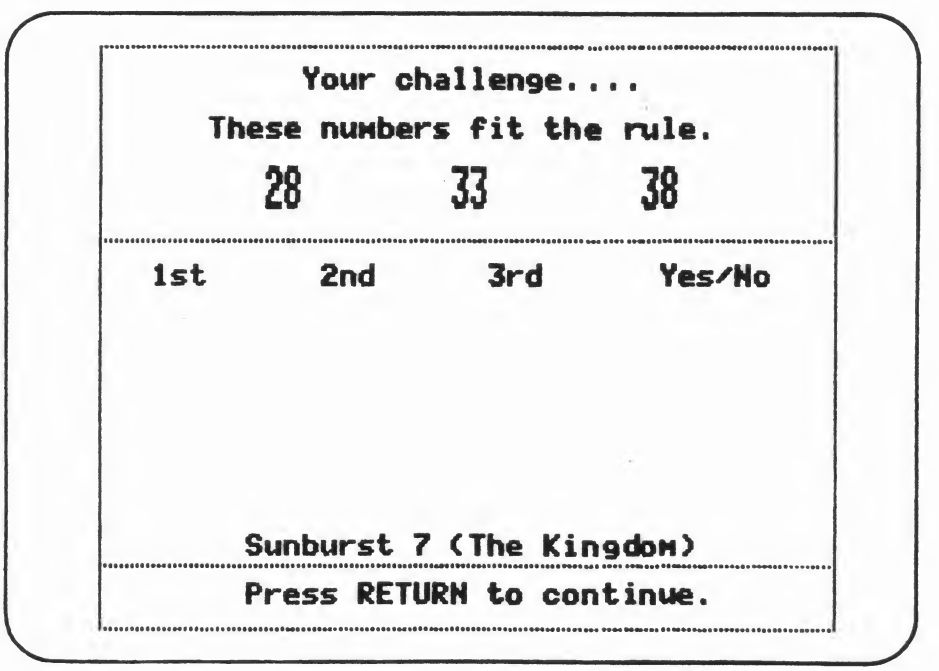
Difficulty Levels

Each difficulty level in this program offers students a different set of rules. This section of the guide contains a list of the rules for each level. Teachers will need to refer to this list whenever they wish to check the current rule under which the program is operating.

Rule Display

At any levels while players are generating and testing hypotheses, teachers may see the current rule under which the program is operating. They may do so by holding the CONTROL (CTRL) key and pressing the T key. A message will then be displayed as follows:

- If the current rule is a Sunburst Rule: The Sunburst Rule number is displayed as listed in this section of the guide for a particular level. The level is also displayed, as shown below:



- If the current rule is a Player Rule: The number of the player who entered the rule is displayed, followed by the level. To view the rule, teachers need to select View Rules through the Change Options (see pages 27-28).

THE ROYAL RULES

Following are the descriptions of the rules of each level of difficulty. Although players may enter the program at any level, they should all be encouraged to work through the first level. Sequential play is not so important on Levels 2, 3, and 4.

Level 1: The City

Rules in Level 1 are transparent. That is, the three numbers given at the start clearly suggest the rule that governs them.

If the rule is "upward jumps of 2," an example might be:

10 12 14

Another typical rule might also be "downward jumps of 2."

14 12 10

If the rule is "downward jumps of 5," the program might present the set:

29 24 19

Here is a list of the Sunburst Rules provided on the Program Diskette for Level 1:

1. Three perfect squares
2. All numbers are divisible by 20
3. All numbers end in 99
4. All numbers are odd
5. Numbers in ascending order
6. Upward jumps of 11
7. Downward jumps of 7
8. The second number is half of the first and the third number is half the second number
9. Upward jumps of 101
10. The third number equals the first number times the second

Here are the types of rules allowed when players formulate and add their own rules:

1. Ends in a particular number
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd

Level 2: The Duchy

Level 2 calls for deep thinking. Here, the third number is the result of an operation--addition, subtraction, multiplication, or division--involving the first two numbers, and in some cases, a constant.

Sunburst Rule 1, for example, is "The third number is double the sum of the first two numbers," or:

$$2(A+B)=C$$

If A (randomly chosen) = 3, and B (randomly chosen) = 0, then C=6 and the number trio is:

3, 0, 6.

What is the third number for 1, 10, ( )? The answer is 22.
Does 1,1,5 fit the rule? No, it doesn't, but 1,1,4 does fit the rule.

Sunburst Rule 2 is:

$$(A+B)^2=C$$

The number trio 0,0,0 fits the rule, and so does 1,5,36.
Does 4,1,2 fit the rule? No, but 4,1,25 does because:

$$(4+1)^2=25$$

Some of the rules displayed in this guide include the terms INT and MOD. INT is used to mean integer part, in other words, "ignore fractional parts" (for example: INT 4.3=4 and INT 7/2=3); MOD is used to mean "the remainder of a division" (for example: 29 MOD 3=2).

Here are the Sunburst Rules for Level 2:

1. $2(A+B)=C$
2. $(A+B)^2=C$
3. $(A-B)^2=C$
4. $(A)(B)(10)=C$
5. $INT((A+B)/2)=C$
6. $A^2-B=C$
7. $7A+B=C$
8. $INT(A/B)=C$
9. $A \text{ MOD } B = C$
10. $A^2+B^2=C$

The Player Rules for Level 2 are based on the formula:

AX+BY+K=C

For example, a possible rule may be "The third number is twice the first number plus twice the second number, plus three," or:

2A+2B+3=C
if A=5, and B=0,
then (2x5)+(2x0)+3=13.

Consequently, the number trio is: 5,0,13.
And what about 1,4,2? Does it fit the rule? No, it doesn't.
But 1,4,13 does fit the rule because:

(2x1)+(2x4)+3=13.

In the Player Rules for The Duchy (Level 2), the following formats are available:

1. A + B + K = C
2. A - B - K = C
3. A + B - K = C
4. A - B + K = C
5. AX + BY + K = C
6. AX - BY - K = C
7. AX + BY - K = C
8. AX - BY + K = C

After selecting a format (such as AX + BY + K = C), players are asked to choose a multiplier for the first number A, a multiplier for the second number B, and a constant, K. In each case, the choices range from -10 to 10. Suppose a player chooses, respectively, 0, 0, and 3. Then the rule is 0 times the first number, plus 0 times the second number, plus 3. The trios 4,5,3, or 9,24,3, and 7,1,3 all fit the rule, but 1,1,4 does not. If the constant K is not desired, one simply can enter 0. Zero can also be used for the multipliers X and Y.

Level 3: The Province

Level 3 differs from previous levels in that the example trios may disguise the rules they represent. Therefore, it is especially important to test several different hypotheses. If the student is presented with the set 100,200,300, the rule may not be as simple as it first appears. Rather than the obvious "multiples of 100" or "jumps of 100," the rule may be more subtle, such as "multiples of 2" or "multiples of 5."

If a player chooses a rule such as "multiples" (and other such rules needing further information), a follow-up question asks for the specific information, for example: "multiples of __," which the player must fill in with a number.

Suppose the example set, 100,200,300, represents the latter rule, "multiples of 5." Many players are likely to assume that the rule could be "multiples of 100," and may start the testing process by submitting other multiples of 100, such as 300,400,900. Since these numbers are also multiples of 5, the test sets do fit the rule. When presented with the quiz, players might then be asked to approve or reject the numbers 100,200,45. They might think that those numbers are not multiples of 100, and accordingly reject the set. Such an answer would be incorrect, and the players would fail the quiz. A better strategy would have been to test the rules "multiples of 10," "multiples of 5," and "multiples of 2," and others. In Level 3, players must be constantly on guard against being misled by the examples disguised.

Following are the disguised examples provided on the Program Diskette, and the actual Sunburst Rule each represents:

1. Disguise: Constant upward jumps
   Rule: Any constant upward OR downward jumps

2. Disguise: Upward jumps of n (n divisible by 3)
   Rule: Constant upward or downward jumps which are divisible by 3

3. Disguise: Constant upward or downward jumps
   Rule: The second number = (the first + the third) divided by 2

4. Disguise: Three consecutive numbers
   Rule: Any constant jumps

5. Disguise: The third number equals the first times the second
   Rule: The third number is divisible by BOTH the first and second

6. Disguise: The third number equals the first plus the second
   Rule: The third number equals the first plus the second

7. Disguise: Upward jumps of 2
   Rule: All even numbers OR all odd numbers

8. Disguise: The third number equals the first times the second
   Rule: The third number is divisible by the first

9. Disguise: Multiples of 100
   Rule: Multiples of 5

10. Disguise: Constant upward jumps
    Rule: The difference of the first number and the third is even

Listed below are the types of rules allowed when teachers and players formulate their own rules for Level 3:

1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Ascending numbers
10. Descending numbers

The same list is given both for the rule and for the disguise. Players may choose to create a rule first or a disguise first (see Creating Rules page 19). Even though the list is the same for rules and disguises, the match-ups are incredibly rich and complex. Here are some possible situations teachers and players can construct:

Disguise: Ends in 1
Rule: All numbers are odd

Disguise: Ends in 0
Rule: Multiples of 2

Disguise: Multiples of 8
Rule: Multiples of 1

Disguise: Constant multiples of 5 (for example, 2,10,50)
Rule: Ascending numbers

Disguise: Multiples of 9
Rule: Multiples of 3

Level 4: The Kingdom

Level 4 uses very simple rules, but is extremely challenging because the rules may apply to only one, at least one, or all three of the numbers presented. For example, the program may present 64,66,68 and the rule could be "At least one number is a perfect square."

THE ROYAL RULES

Following are "disguised" examples given by the Sunburst program, and the actual rule each represents:

1. Disguise: Upward jumps of n
   Rule: Numbers in ascending order

2. Disguise: Multiples of 100
   Rule: Multiples of 4

3. Disguise: Multiples of 100
   Rule: The sum of the numbers is divisible by 4

4. Disguise: Three ascending squares
   Rule: All numbers are squares

5. Disguise: Constant upward jumps
   Rule: The first number is the smallest

6. Disguise: Three multiples of n
   Rule: At least one number is a multiple of n

7. Disguise: Upward jumps of n (n is odd)
   Rule: At least one number is even

8. Disguise: Three consecutive even numbers
   Rule: Ascending OR descending numbers

9. Disguise: Three numbers greater than one where the third number equals the first times the second
   Rule: The third number is the largest

10. Disguise: Three positive numbers where the third number is the first minus the second
    Rule: The first number is the largest

In constructing Player Rules (and disguises) for Level 4, teachers and players are asked whether they want their rule to apply to:

All of the numbers
At least one of the numbers
Only one of the numbers.

They are then asked for a disguise and a rule. <u>For rules involving only one of the numbers, no disguise is used as the situations are difficult enough as presented</u>.

If the rule applies to all of the numbers, the rule and the disguise are chosen from the following list:

1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Ascending numbers
10. Descending numbers
11. Consecutive even numbers
12. Consecutive odd numbers

If the rule applies to at least one of the numbers, the choices listed above are available for disguises, while the choices listed below are available for rules:

1. Ends in digit
2. Multiple
3. Odd number
4. Even number
5. Square

And if the rule applies to only one of the numbers, the rule must be selected from the following choices:

1. Ends in digit
2. Multiple
3. Odd number
4. Even number
5. Square
6. Smallest
7. Largest

In this manner, a wealth of situations can be created, as shown in the following examples:

Disguise: Consecutive even numbers
Rule: Multiples of 2

Disguise: Constant upward jumps of 1
Rule: At least one number is odd

Disguise: Ends in 0
Rule: At least one number is even

Disguise: Constant downward jumps of 2
Rule: Descending numbers

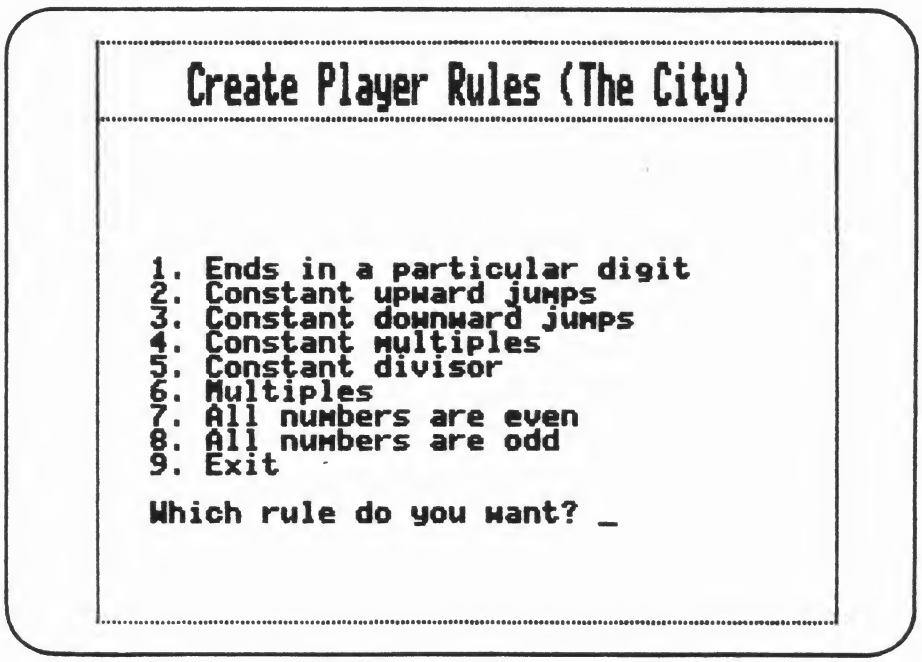
Disguise: (Not necessary since the rule pertains to only one number)
Rule: Third number is a square

Creating Rules

Teachers can enter rules through the Change Options (see page 29). Through the Change Options, teachers can also allow students to enter their own rules (see Rule Option page 27).

When teachers or players add a rule of their own, the rule is saved on the Data Diskette so that others may play against it. If one disk drive is used, a message will be displayed whenever the diskettes must be exchanged. If a two-disk drive system is used, the computer will automatically switch back and forth between the two diskettes.

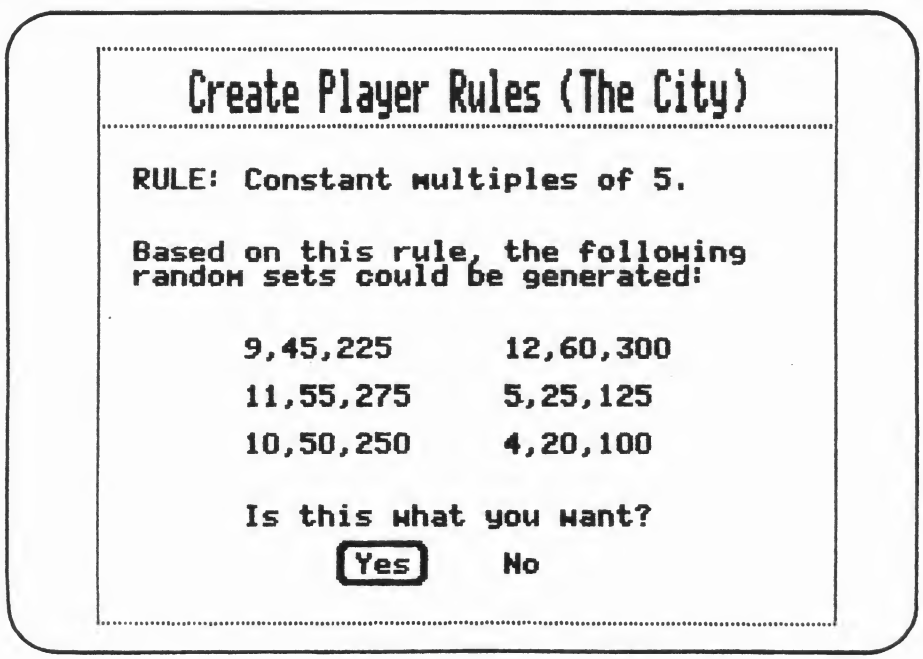
On Level 1, teachers or players are prompted for a rule by choosing from a list of available rules as shown below.


Create Player Rules (The City)
1. Ends in a particular digit
2. Constant upward jumps
3. Constant downward jumps
4. Constant multiples
5. Constant divisor
6. Multiples
7. All numbers are even
8. All numbers are odd
9. Exit
Which rule do you want? _

In some cases (for example, constant multiples), players are asked to choose a number within a given range of numbers.

Finally, the player must enter a sample trio depicting the rule. If the sample does not fit the rule, the teachers or players are given the chance to try again, as in the following example:

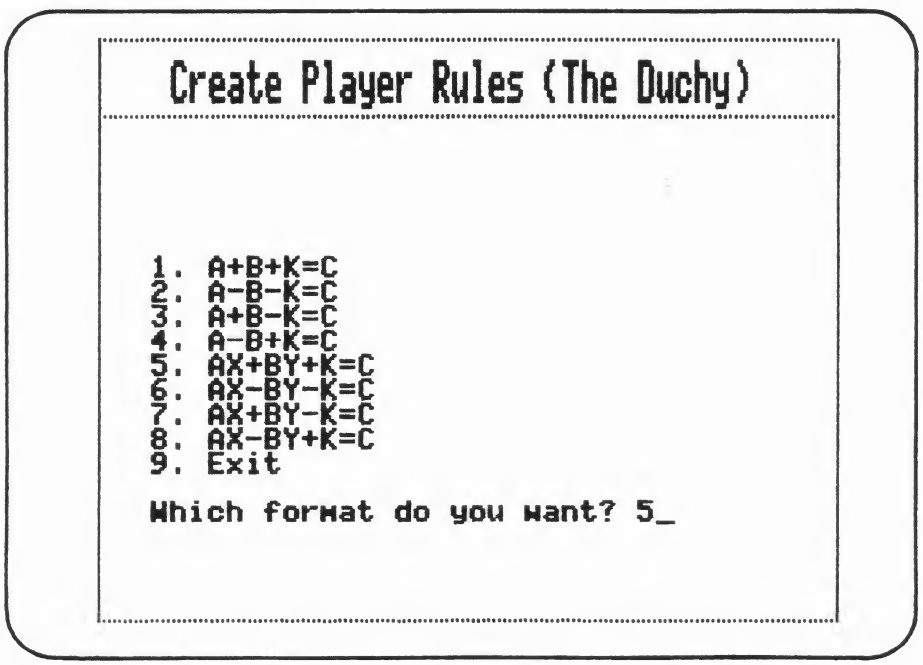
After a correct set of numbers has been entered, teachers or players are shown a list of possible sets which fit the rule. They are then asked whether they are satisfied with the results displayed, as in the example shown below:



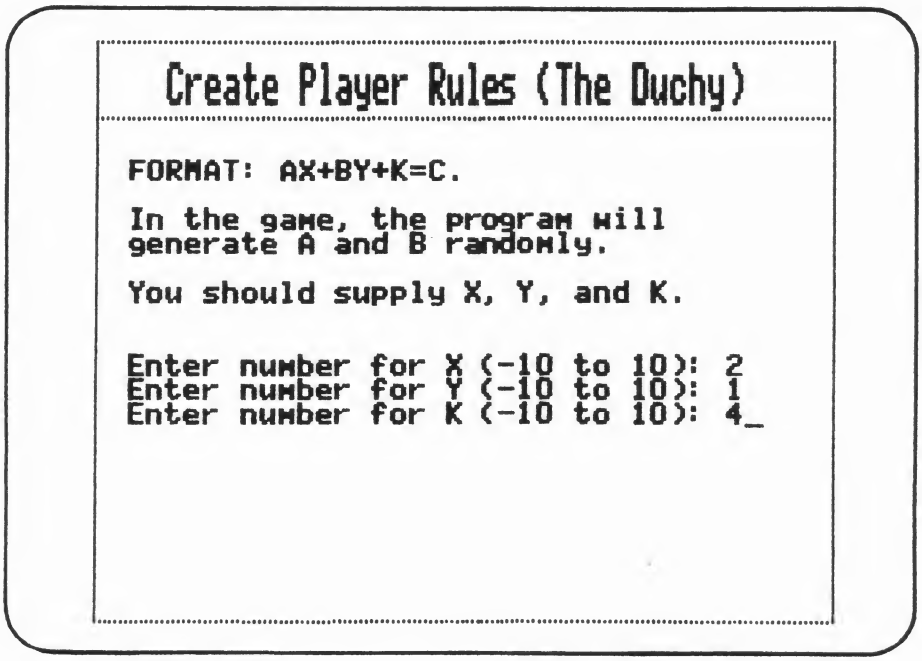
If they are not satisfied with the results, they get another chance at entering a rule. Once a player is satisfied with the rule, his or her name is requested and the rule is saved under that name on the Data Diskette. Players or teachers then have the option of entering another rule or returning to the menu.

Players and teachers can enter as many rules as desired. To do so, players must first pass three quizzes, while teachers can choose Create Player Rules from the Change Option menu (see Change Options page 27). It is possible for one player to fill an entire Data Diskette with rules for others to play against.

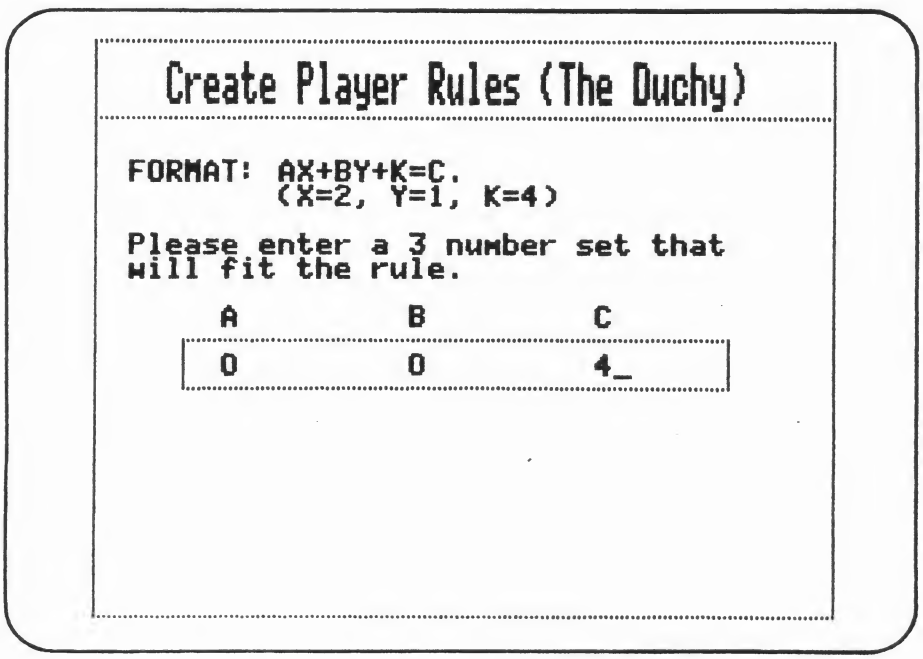
On Level 2, the same procedure as on Level 1 is used to enter rules, but the format chosen to define the rule is different, as shown below:



Players or teachers must define X,Y,K, as the program will generate A and B randomly:

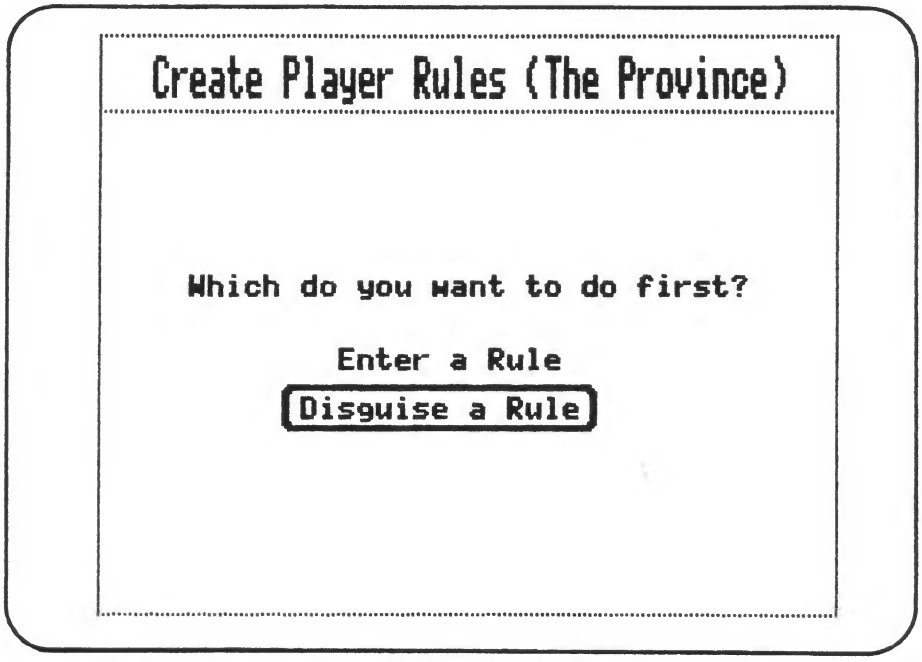

Create Player Rules (The Duchy)
FORMAT: AX+BY+K=C.
In the game, the program will generate A and B randomly.
You should supply X, Y, and K.
Enter number for X (-10 to 10): 2
Enter number for Y (-10 to 10): 1
Enter number for K (-10 to 10): 4_

Here again, a sample of the rule is requested in which the first, second, and third number of the set must be entered.



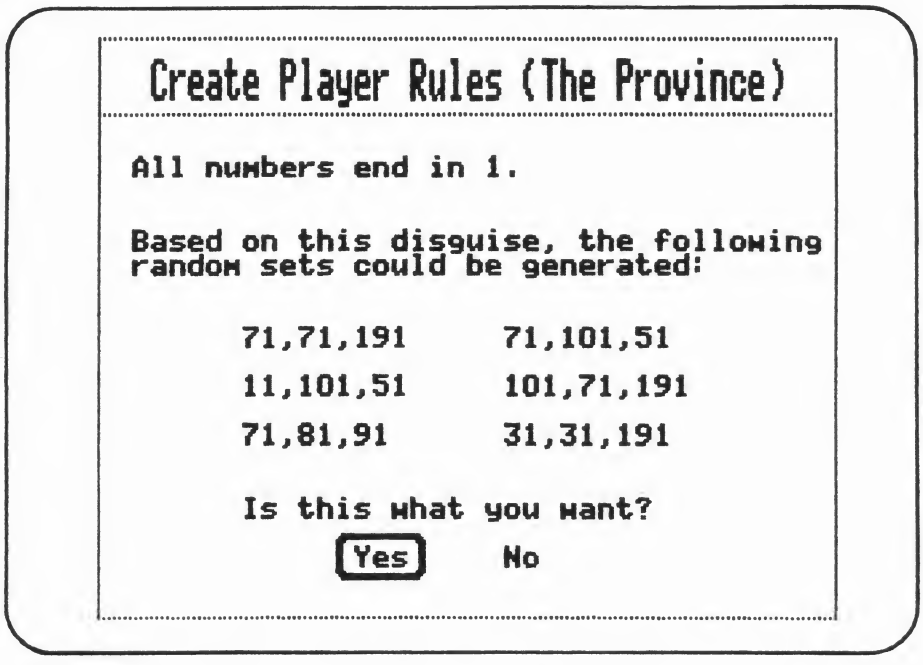
Number trios are then generated, and teachers or players are asked whether they are satisfied with the results displayed.

On Levels 3 and 4, teachers or players must create a rule and a disguise for the rule. They may choose the order in which they wish to proceed, as shown below:

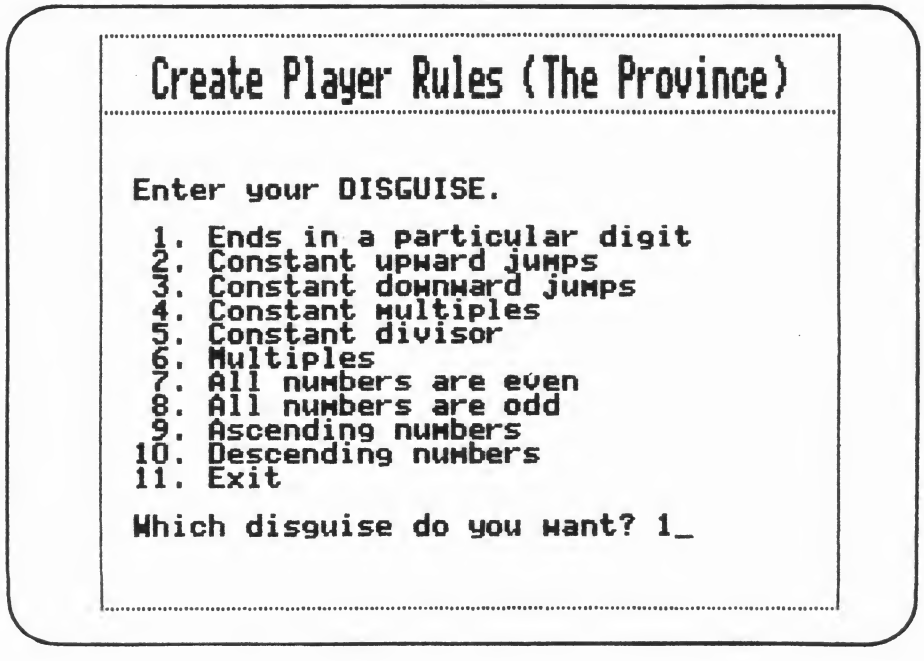


When choosing Disguise a Rule, teachers or players choose a disguise, in this case, "Ends in a particular digit" from a list of available disguises, as shown below:

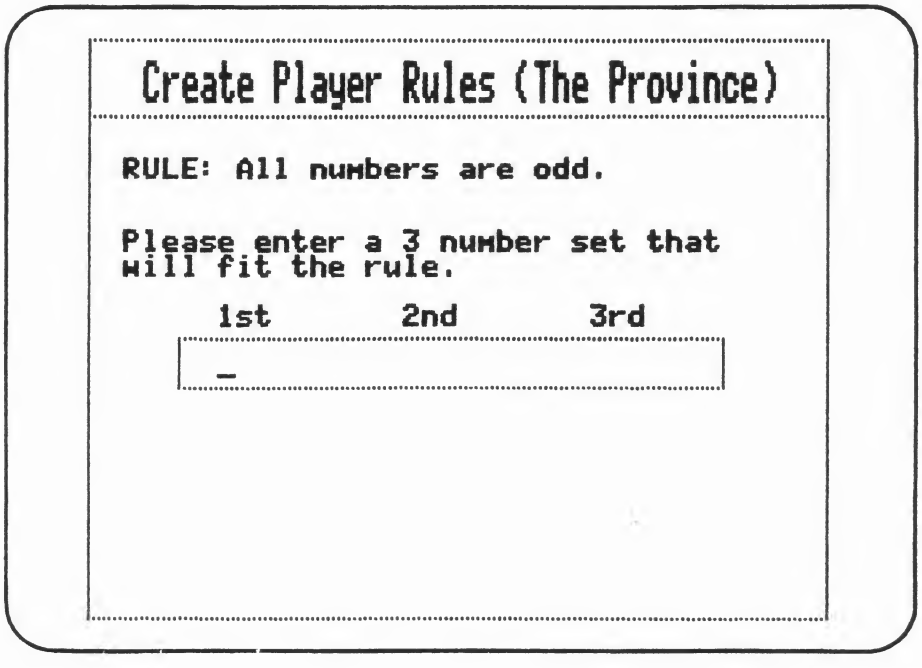
After selecting the particular number needed for the disguise (for example 1), players are asked to provide a number trio which fits the disguise. If the three numbers fit the disguise, players are then shown other number trios, randomly generated as in the example below:



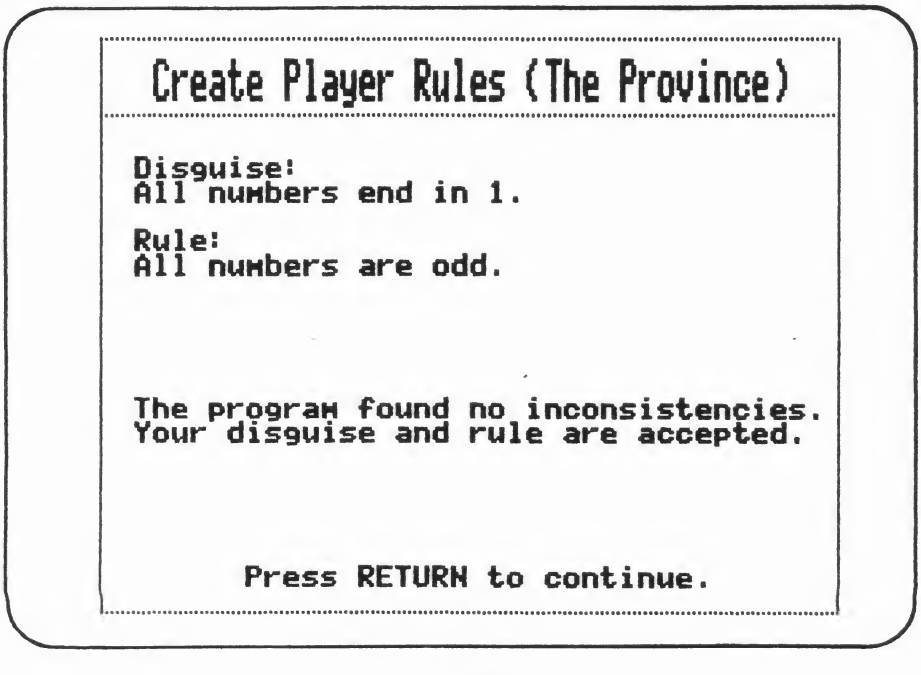
If they have created a disguise first, teachers or players must then enter a rule. They do so by choosing, as in the other levels, from a list of available rules, as shown below:



Suppose a player chooses "All numbers are odd," for the rule (the disguise is still "All numbers end in 1"). A display similar to the one below will then be shown:

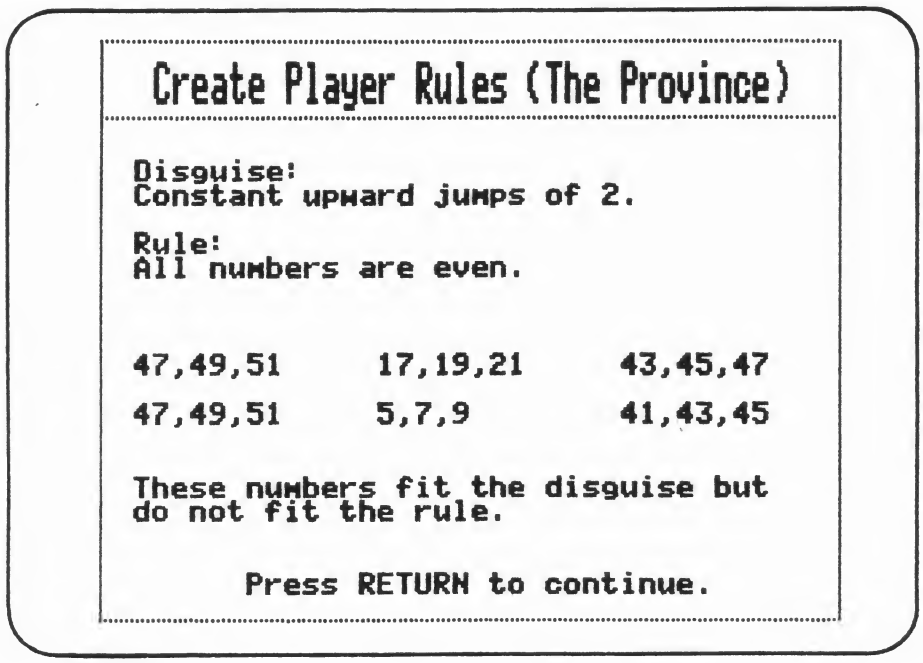


All possible examples of the disguise (in this case 91,111,131, and 11,71,121, and so forth) must fit the rule. A consistency check is then performed on randomly selected examples of the disguise to see if they fit the rule, as shown below:



If no inconsistencies are found, the player is then asked to enter his or her name. The rule and the disguise are then saved on the Data Diskette under the player's name.

If a disguise and a rule fail the consistency check, the player is given a message as follows:

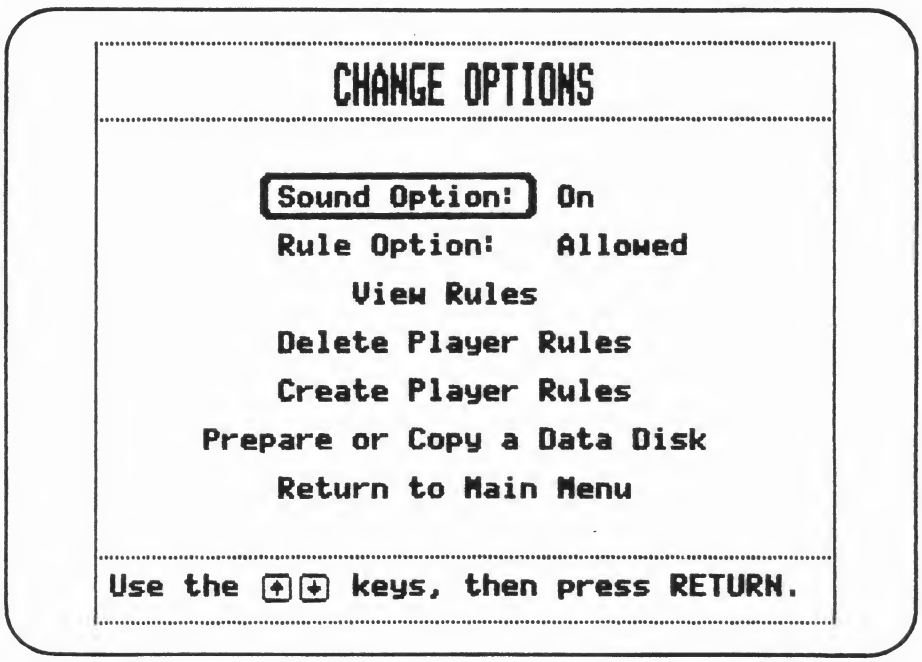

Create Player Rules (The Province)
Disguise:
Constant upward jumps of 2.
Rule:
All numbers are even.
47,49,51 17,19,21 43,45,47
47,49,51 5,7,9 41,43,45
These numbers fit the disguise but do not fit the rule.
Press RETURN to continue.

The player would then be given the opportunity to change either the rule or the disguise or to start over.

After selecting the disguise in Level 4, players may choose to have the rule apply to all the numbers, or at least one of the numbers. If the rule is entered first, the players may also choose to make the rule apply to only one of the numbers. When applying the rule to only one of the numbers, no disguise will be needed.

Change Options

Several change options are provided to enrich the use of The Royal Rules and to give teachers control of the learning situation. By holding down the CONTROL (CTRL) key and T key at the main menu, teachers can make important decisions on behalf of the players, as shown below:



Sound Option

This option allows the teacher to choose whether the sound will be on or off during the program. Answering the question "Do you want sound?" will allow the teacher to turn the sound off or on. The sound will then remain in the mode selected until the Sound Option is used again.

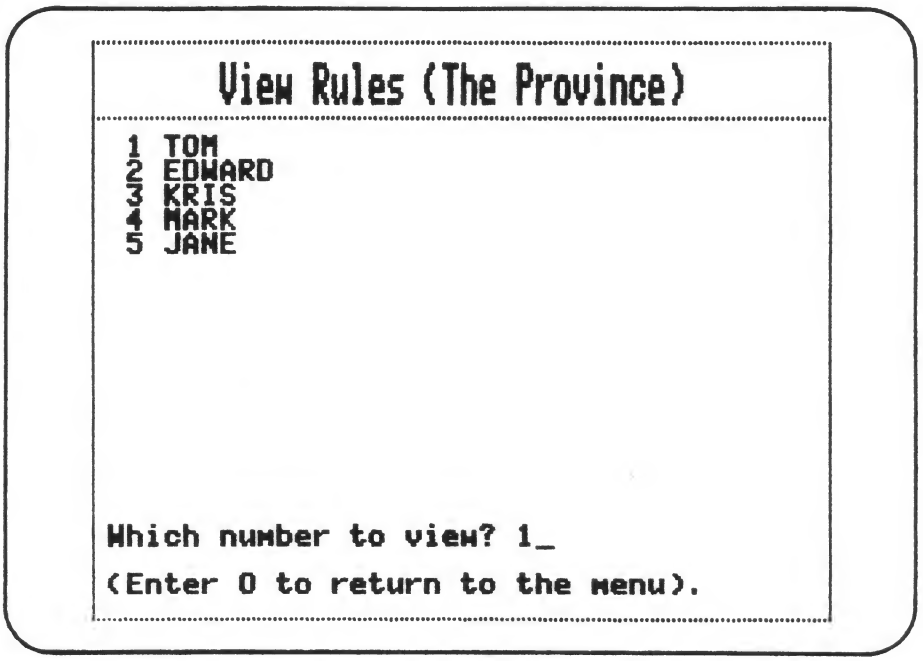
During the game, when the sound is turned on players can then toggle at their discretion between sound on or off by holding down the CONTROL (CTRL) key and pressing S.

Rule Option

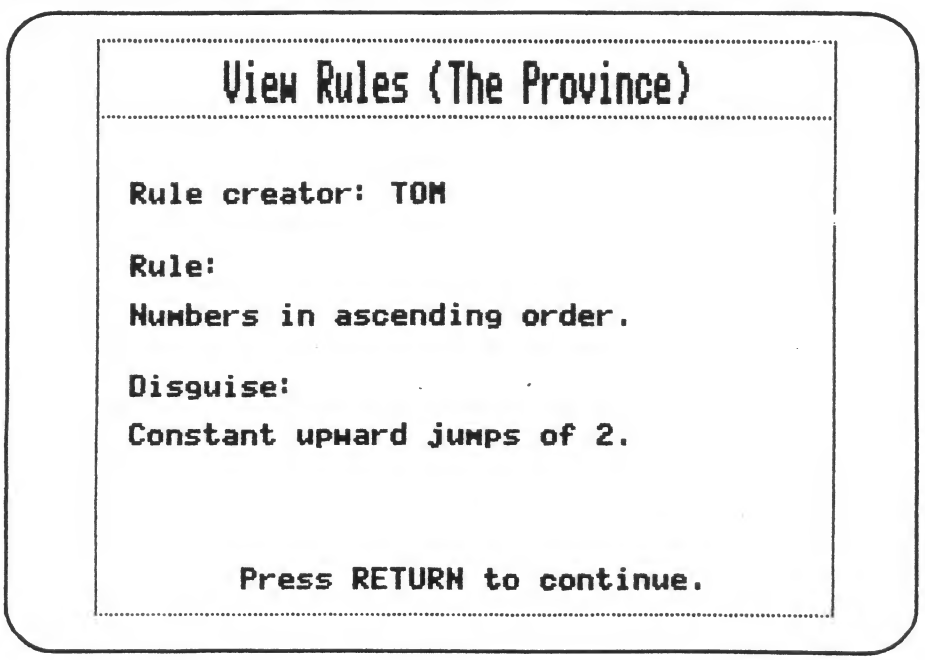
This option allows teachers to turn the Rule Option on or off. When the Rule Option is turned on, players who have successfully completed three quizzes, at any one level, will be given the option of entering their own rules. Since teachers may wish to focus the players' attention on certain types of rules, they can turn the Rule Option off, thus preventing new rules from being added by players. Once the option has been turned off (or on), it will remain in the mode selected until this option is used again.

View Rules

This option allows teachers to view the rules created by the players. Teachers first choose the level (for example: The Province), then the particular rule(s) to be viewed. The rules are listed by the names of the players who entered them. Here's a look at how the players' names are listed for a chosen level (The Province):



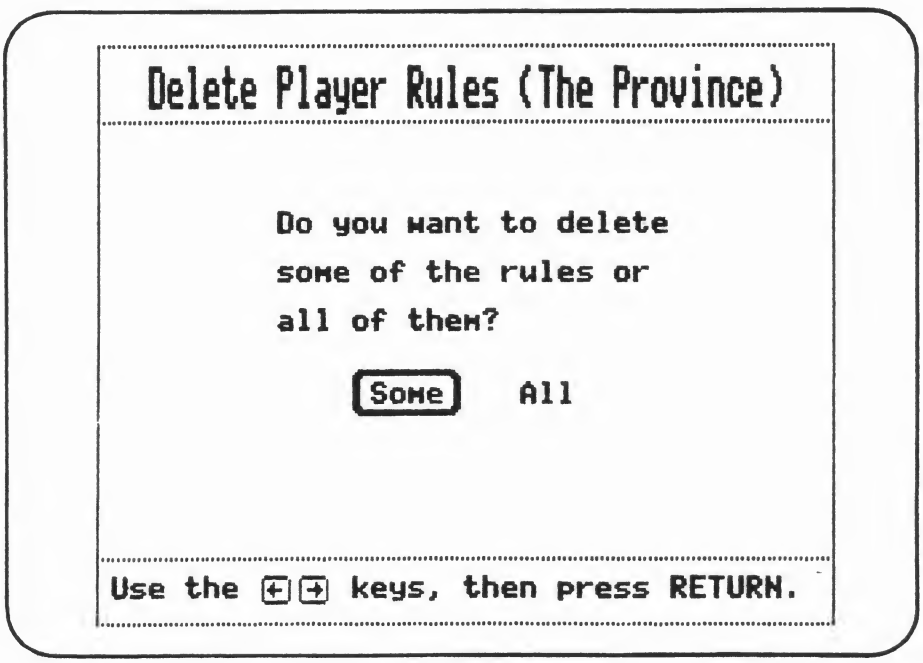
After choosing the name of the player whose rule will be viewed, the teacher is then given information as shown below:



Teachers may get a printout of Player Rules at each of the four levels. To obtain this printout with any type of printer, they need to hold down the CONTROL (CTRL) key and press the P key when asked "Which number to view?" All the Player Rules in that level will be sent to the printer. Before printing begins, the question, "Which slot is your printer card in?" is displayed (on the Apple IIc: "Which port is your printer attached to?"). The printer card is usually in slot 1 (on the Apple IIc, printer attached to port 1).

Delete Player Rules

This option allows teachers to delete some of the Player Rules (because of redundancy), or all of the Player Rules. After choosing the level, teachers are asked the following question:


Delete Player Rules (The Province)
Do you want to delete some of the rules or all of them?
Some
All
Use the ← → keys, then press RETURN.

To delete some of the rules, teachers choose from a list of names under which these rules were entered. If they choose to delete all of the rules, teachers will be given the opportunity to change their mind.

Create Player Rules

Perhaps most important, teachers can add rules of their own--as many as they want--and at any level of the program. (See Creating Rules page 19.)

TABLE OF CONTENTS

Introduction 1

Problem Solving Skill Matrix 3

Program Overview 4
- Program Description 5
- Work Room 1 6
- Work Room 2 8
- Work Room 3 9
- Work Room 4 11
- Quality Control Room 1 13
- Quality Control Room 2 14
- Teacher Options 16

Overview of Lessons 18
- Lesson Description Chart 19
- Lesson Sequence Chart 20
- Definitions 21
- What's Your Guess? *(a pre-computer, whole class lesson)* 22
- Predicting *(a pre-computer, small group lesson)* 24
  - Keeping Track Student Activity Sheet #1 26
- What's Your Pick? *(a pre-computer, whole class lesson)* 27
  - Keeping Track Transparency Master #1 29
- Picking and Choosing *(a pre-computer, small group lesson)* 30
- Putting It Back *(a whole class lesson)* 31
  - Making Predictions Transparency Master #2 33
- Back It Goes *(a pre-computer, small group lesson)* 34
  - Making Predictions Student Activity Sheet #2 36
- Work Room 1 *(a computer lesson)* 37
- Work Room 2 *(a computer lesson)* 38
- Work Room 3 *(a computer lesson)* 39
- Work Room 4 *(a computer lesson)* 40
- Quality Control Room 1 *(a computer lesson)* 41
- Quality Control Room 2 *(a computer lesson)* 43
- If You Ask Me *(a post-computer, small group lesson)* 45
  - If You Ask Me Student Activity Sheet #3 46
- Marbles to the Rescue *(a pre-computer, small group lesson)* 47
  - Marbles to the Rescue Student Activity Sheet #4 49
- Machine Builders *(a post-computer, small group lesson)* 50
  - Machine Builders Student Activity Sheet #5 51

Writer's Forum *(a post-computer lesson)* 53
The Probability Post Student Activity Sheet #6 56
Real Life *(a post-computer lesson)* 57
A Walk in the Woods Student Activity Sheet #7 59
Picking Flowers Student Activity Sheet #8 60
Car Tracking Student Activity Sheet #9 61
Decisions, Decisions Student Activity Sheet #10 62
Uncle David's Visit Student Activity Sheet #11 63
Aunt Pam's Present Student Activity Sheet #12 64
The Job Jar Student Activity Sheet #13 65
Keeping a Line on the Situation Student Activity Sheet #14 66
Balloons for Linda Student Activity Sheet #15 67
The Job Jar Revisited Student Activity Sheet #16 68
Sunny Choices Student Activity Sheet #17 69

Resources 70

At a Glance 71

Apple: Working with Your Computer 73
Apple IIGS: Control Panel Settings 74
Apple: Working with Your Muppet Learning Keys 75

"What Happens If...?" Sunburst Courseware and Warranty 76

INTRODUCTION

Probability is not a spectator sport. We all think about the likelihood of an event: Will it snow in December? Who will win the World Series this year? What are the chances of a meteor falling on my house?

When we think about the likelihood of an event we frame a theory ("A meteor will probably not fall on my house."). Then we try out our theory on other people ("Do you think a meteor will fall on my house?"), collect data to check our hypothesis, analyze the data, and check it against our experience.

Taking Chances provides an opportunity for students to conduct probability experiments in their own classrooms. It is designed to develop students' understanding of the laws of chance and increase their knowledge of how those laws operate.

In **Taking Chances** students learn how sampling with replacement produces different results from sampling without replacement by experimenting in four Work Rooms and two Quality Control Rooms. In each Work Room, students are presented with a machine that contains colored marbles. They are asked to predict how many of each color will fall out of the machine. Some rooms have machines that sample and then replace the marbles, while in other rooms the marbles fall out and are not replaced. In the Quality Control Rooms, students make predictions based on given information.

Mathematical Foundations

Probability is an important mathematical topic, rich in theory and real world applications. The National Council of Teachers of Mathematics (NCTM), recognizing probability's importance, urges schools to increase students' understanding of chance events. *The Curriculum and Evaluation Standards*, recently published by NCTM, says students should conduct probability experiments, record and analyze data, and reframe their theories to accommodate the data. But, in spite of its importance, probability seldom finds a place in the classroom. And when it is taught, probability is presented as a set of formal equations, unrelated to daily life.

Taking Chances and the accompanying lessons give students an opportunity to explore randomness and to predict the likelihood of events. First with a marble machine and then with everyday situations, students can build and test their own theories. They learn to record and interpret data, and recognize predictable patterns—skills they will need for a mature study of probability.

Educational Foundations

Piaget and other researchers have shown us that young children believe their thoughts determine the outcome of an event. "If I wear a yellow hat, the sun will come out," they say. So it is no wonder they find probability confusing. If an outcome does not match their expectations, they dismiss it or they believe they just have to concentrate harder.

For example, Lillian, age 7, when working with **Taking Chances**, found that marbles she selected did not get ejected by the machine. She said, "This time I am going to make that marble fall out." She was convinced that the marbles could obey or disobey her wishes. Decentering, or learning that they do not cause events, is an important cognitive step forward for children.

As children begin to understand the laws governing the occurrence of events, they will become curious about those laws. Older children, with their ability to coordinate different bits of information, can understand more of probability than their younger brothers and sisters. But even then, children experience difficulties. Alexander, the 13-year-old brother of Lillian, saw that the machine was choosing marbles randomly and could talk about sampling without replacement, anticipating what would happen on the last turn of the machine. But when he chose the wrong machine in Quality Control Room 1 several times in a row, he said, "Now there's an error in the program." His ability to coordinate information extended just so far. **Taking Chances** is designed to enhance children's ability to coordinate information by working systematically and collaboratively with probabilistic events.

Child development researchers have also shown us that young children learn best by working with concrete problems. The activities in **Taking Chances**, both on- and off-computer activities, provide children hands-on experience with chance events that will enhance their skills with probability.

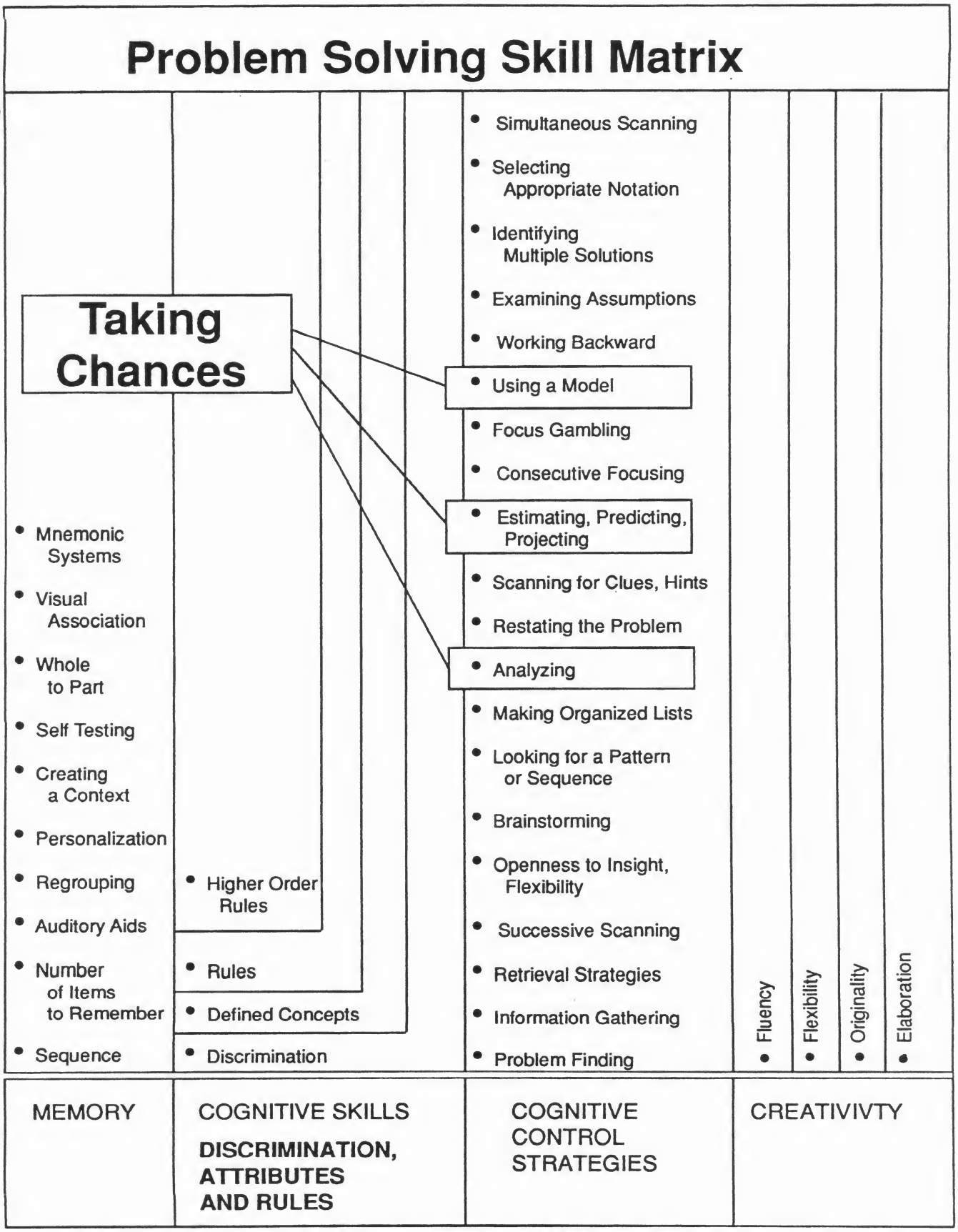
The Role of the Computer

Computers are ideal tools for teaching probability. They can present simulations of events, keep track of students' choices, reward correct choices, and provide helpful hints. The computer can also repeat the same problem over and over, allowing students the opportunity to explore probability.

The computer isn't a teacher, but it can set up the teachable moment. Teachers can then begin a dialogue with students so that an understanding of randomness and chance is internalized and applied.

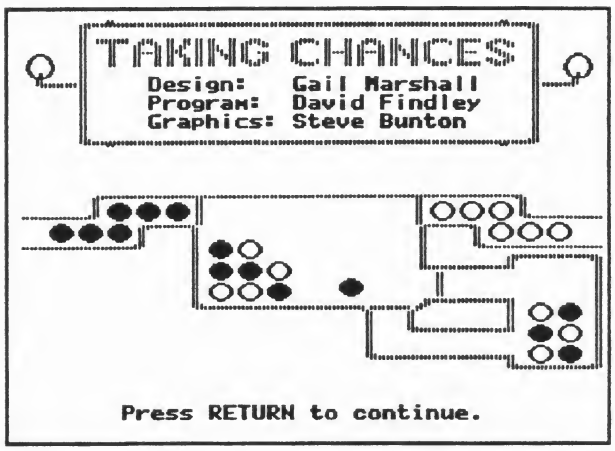
If students are to work with probability situations and learn from them, they must be encouraged to build and test theories, keep and analyze records, and interpret events. They must actively engage the computer-generated situations. The teacher sets the stage, the computer provides the examples, and the students grapple with the data. The combination of these three components will promote an understanding of probability.

Problem Solving Skill Matrix



This matrix was developed under a Title IVC grant to Rochester, MN, schools under the direction of Donna Stanger. The matrix is based on the works of Gagne, but also reflects Piaget, Guilford, Meeker, Bruner, Bloom, and Torrence.

PROGRAM OVERVIEW



Grade: 3 - adult

Objectives:

- Develop intuitive ideas about the laws of probability
- Test theories about probability laws
- Record data and learn to analyze the data to predict events
- Collaborate with other students and use manipulatives to increase understanding of probability

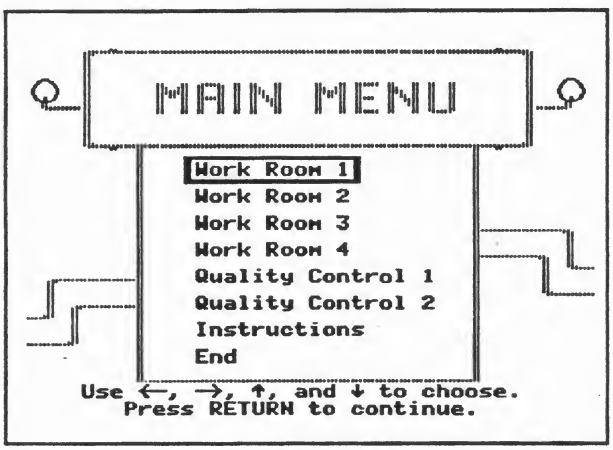
All of the objectives can be realized with each activity. A combination of computer use, hands-on use of manipulatives, students' individual and group exploration of the Work Rooms and Quality Control Rooms in the software, and direct instruction should be part of the instructional sequence.

Time Required: Individual computer activities can be accomplished in 10 to 25 minutes. Classroom activities may range from 15 to 40 minutes.

PROGRAM DESCRIPTION

Main Menu

Taking Chances begins with a display of the MAIN MENU from which students may choose one of the six activities: Work Rooms 1, 2, 3 or 4 and Quality Control Rooms 1 or 2. Or, they may review the Instructions and then return to the MAIN MENU and choose a room.

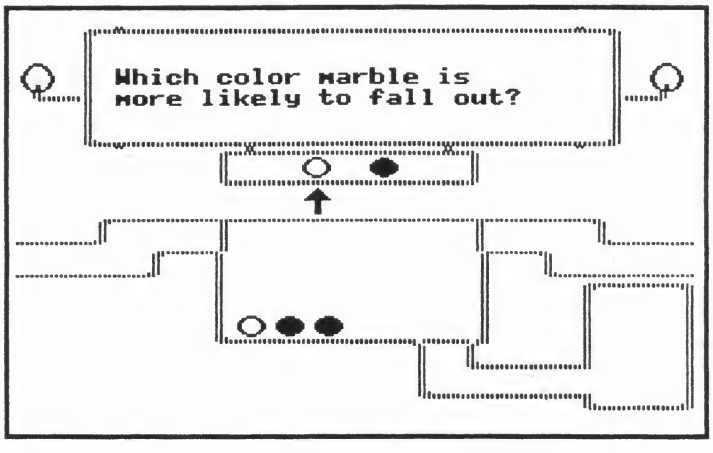


Students choose an activity by moving the selection box with the arrow keys (←, → , ↑, ↓) and then pressing RETURN on the Apple keyboard or GO on the Muppet Learning Keys™.

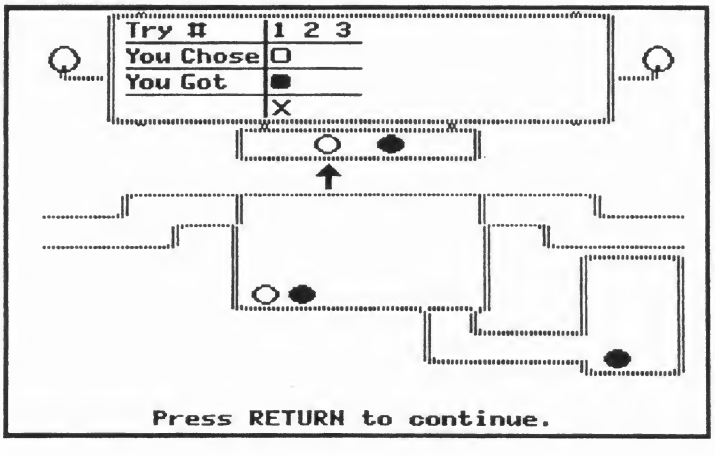
The MAIN MENU can be accessed at any time during the program by pressing CONTROL-E.

Work Room 1

Work Room 1 displays a machine filled with marbles. Students must decide which color marble is more *likely* to be ejected from the machine. The machines in this Work Room are set for *sampling without replacement*, that is, the marbles are not returned to the machine after they fall out.

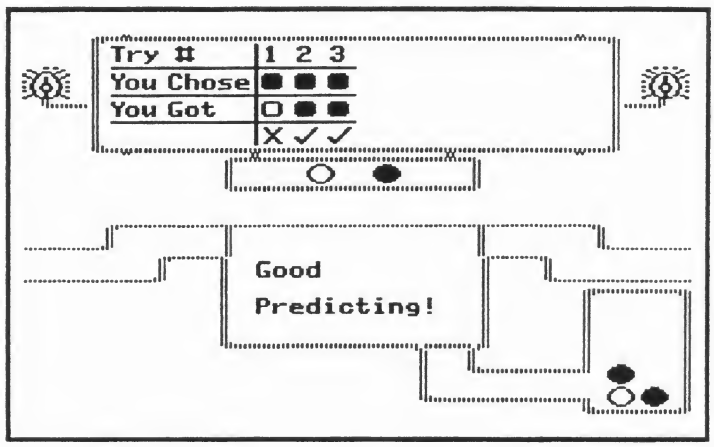


Students use the arrow keys (←, →) to select the color marble and then press RETURN to activate the machine. A marble will fall out.

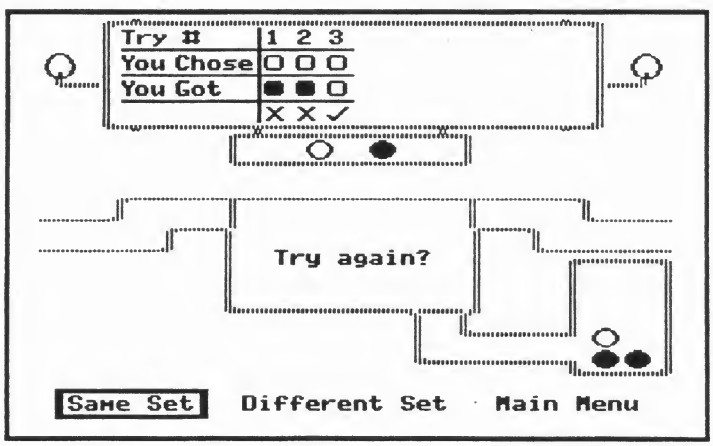


Students then repeat the process until all the marbles are ejected.

When all the marbles are ejected from the machine, students will see a scoreboard that compares their predictions with the results. If students' predictions match the results, they see a congratulatory message.



If their predictions do not match, the message encourages them to try again.



After the problem is completed, students are offered a choice of the SAME SET, a DIFFERENT SET, or returning to the MAIN MENU. SAME SET repeats the problem by producing the identical set of marbles that was in the original machine. Therefore, students are allowed a second (or third, or more) test of predictions and outcomes.

DIFFERENT SET produces a new machine with a different set of marbles. If the Teacher Option is set to SEQUENTIAL, the new machine will display one more marble than the previous machine. If the option is set to RANDOM, the new machine will display a randomly generated set of marbles.

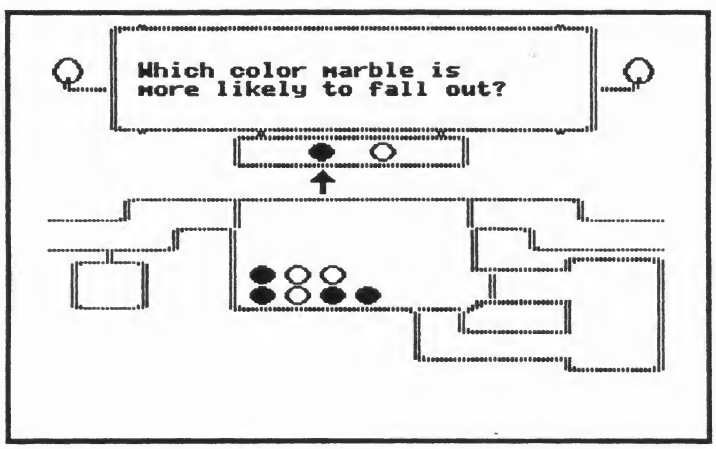
After students have worked with a few machines, they'll be asked if they would like to go to the Quality Control Room. If they answer "Yes," they'll automatically move to a Quality Control Room where they will have the opportunity to use their understanding of probability to interpret a scoreboard. If they answer "No," students may select DIFFERENT SET or return to the MAIN MENU.

Students may select another room or exit the program by returning to the MAIN MENU.

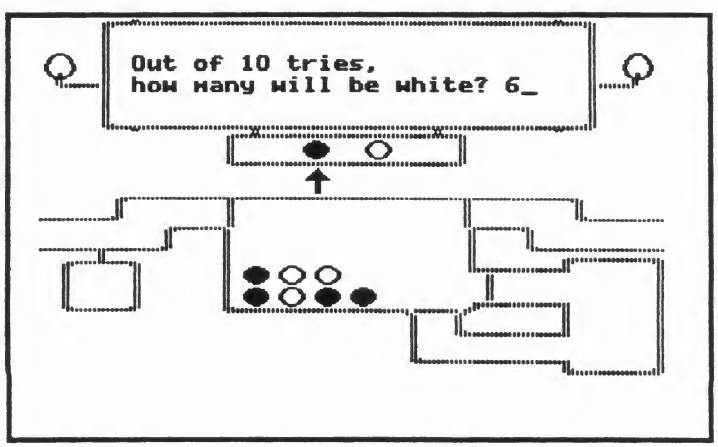
Work Room 2

Work Room 2 displays a machine filled with marbles. Students must decide which color marble is more likely to be ejected from the machine and predict how often it will fall out. The machines in Work Room 2 are set to *sampling with replacement*, that is, the marble leaves the chamber, makes a circuit, and then returns to the machine.

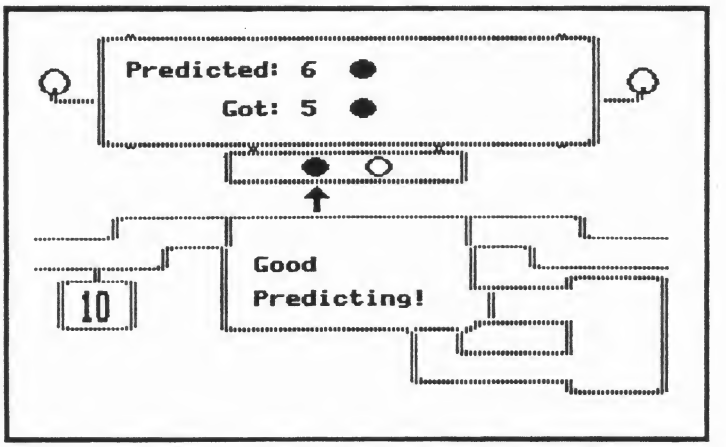
Students use the arrow keys (←,→) to select the color of the marble most likely to fall out and then press RETURN.



Students then enter an estimate of the number of times they think the color they have chosen will fall out of the machine and press RETURN to activate the machine.



The machine will go through ten cycles, counting each cycle and recording the number of times the predicted color falls out.



After the problem is completed, students are offered a choice of the SAME SET, a DIFFERENT SET, or returning to the MAIN MENU. SAME SET repeats the problem by producing the identical set of marbles that was in the original machine. Therefore, students are allowed a second (or third, or more) test of predictions and outcomes.

DIFFERENT SET produces a new machine with a different set of marbles. If the Teacher Option is set to SEQUENTIAL, the new machine will display one more marble than the previous machine. If the option is set to RANDOM, the new machine will display a randomly generated set of marbles.

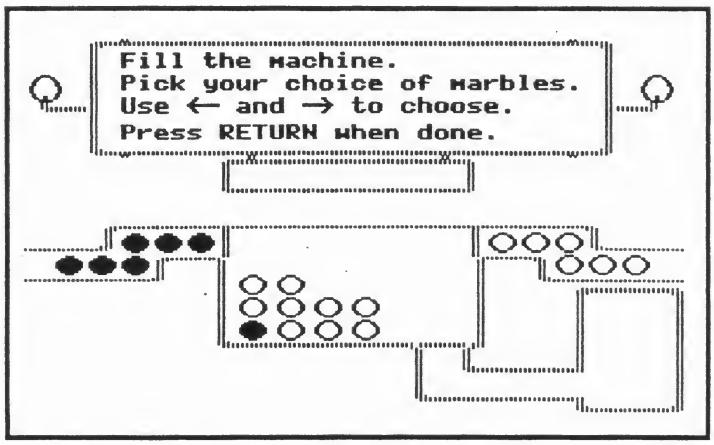
After students have worked with a few machines, they'll be asked if they would like to go to the Quality Control Room. If they answer "Yes," they'll automatically move to a Quality Control Room where they will have the opportunity to use their understanding of probability to interpret a scoreboard. If they answer "No," students may select DIFFERENT SET or return to the MAIN MENU.

Students may select another room or exit the program by returning to the MAIN MENU.

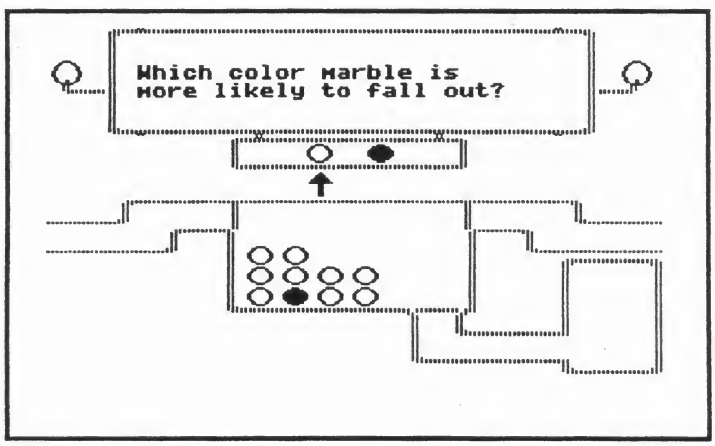
Work Room 3

Work Room 3 allows students to fill the machine with up to ten marbles, predict the color marble more likely to fall out of the machine on each turn, and check their predictions. Sampling of the marbles from the machines occurs *without replacement* in the machine.

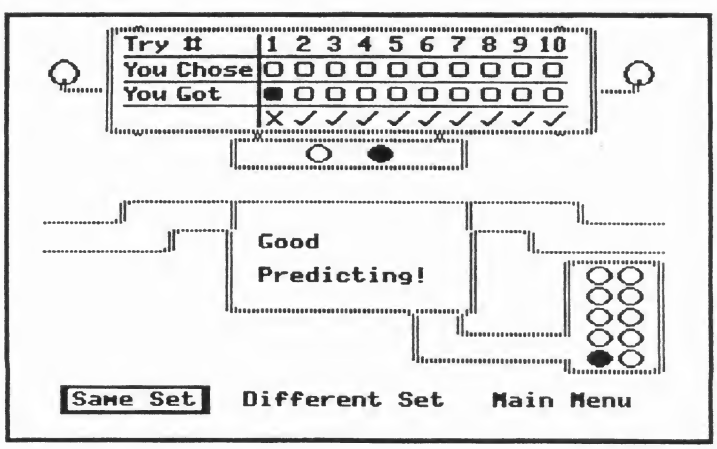
Students must add at least one marble to the machine. They must use the arrow keys (←,→) to select each marble and press RETURN when all the marbles have been added.



Students now enter the color most likely to be ejected from the machine with the arrow keys. They must press RETURN to activate the machine and repeat the cycle of choosing and predicting until all the marbles have been ejected.



When the process is complete, a message appears on the screen. If the students' predictions match those of the machine, they will see a congratulatory message.



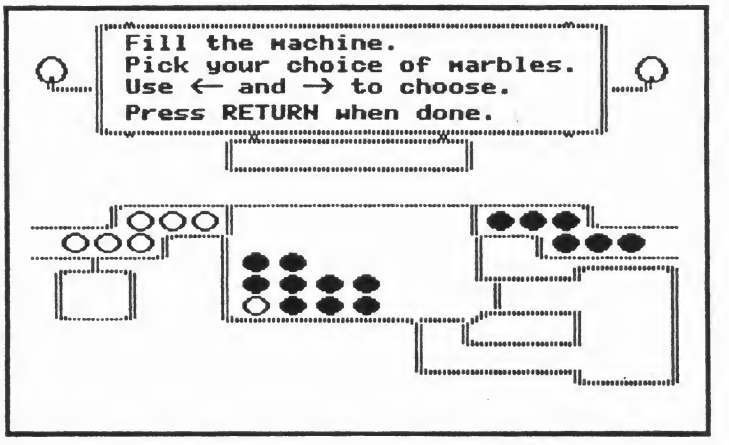
After the problem is completed, students are offered a choice of the SAME SET, a DIFFERENT SET, or returning to the MAIN MENU. SAME SET repeats the problem by producing the identical set of marbles that was in the original machine. Therefore, students are allowed a second (or third, or more) test of predictions and outcomes.

DIFFERENT SET produces a new machine with a different set of marbles.

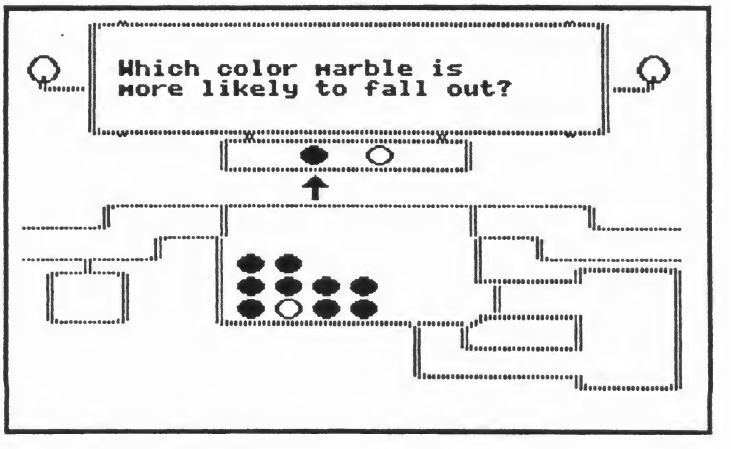
Students may select another room or exit the program by returning to the MAIN MENU.

Work Room 4

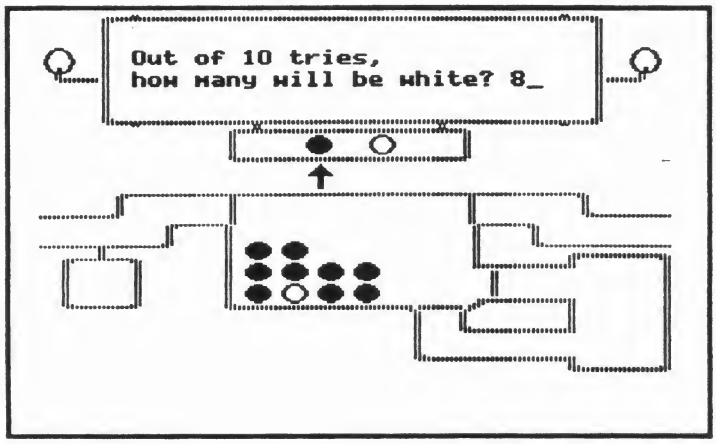
Work Room 4 also allows students to fill the machine with up to ten marbles and predict which color marble is more likely to fall out of the machine. Then the machine goes through ten cycles of sampling the marbles and replacing them (i.e., *sampling with replacement*).



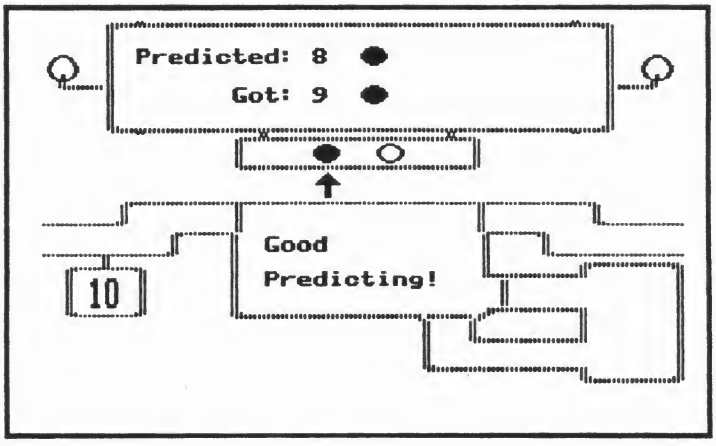
Students use the arrow keys (←,→) to select each marble and press RETURN when all the marbles have been added. Students then choose the color marble which is more likely to be ejected by using the arrow and RETURN keys.



Next, students must decide how many times that color marble will be ejected in ten tries.



Students then press RETURN to activate the machine. *Sampling with replacement* will occur. After a marble is ejected it returns to the machine. When all the marbles have been ejected the scoreboard shows the prediction with the actual outcome. If students' predictions match the results, they'll see a congratulatory message.



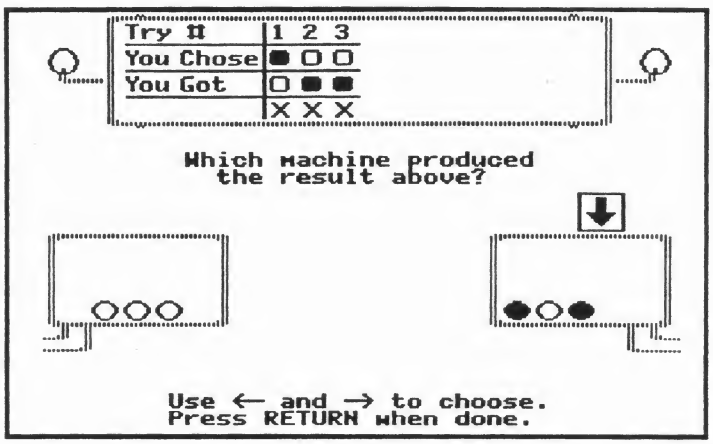
After the problem is completed, students are offered a choice of the SAME SET, a DIFFERENT SET, or returning to the MAIN MENU. SAME SET repeats the problem by producing the identical set of marbles that was in the original machine. Therefore, students are allowed a second (or third, or more) test of predictions and outcomes.

DIFFERENT SET produces a new machine with a different set of marbles.

After students have worked with a few machines, they'll be asked if they would like to go to the Quality Control Rooms. If they answer "Yes," they'll automatically move to a Quality Control Room. If they answer "No," students may select SAME SET, a DIFFERENT SET, or return to the MAIN MENU. Students may select another room or exit the program by returning to the MAIN MENU.

Quality Control Room 1

Quality Control Room 1 shows a scoreboard and two machines. Sampling without replacement has occurred, that is, when marbles leave the machine they disappear. Students must decide which machine is more likely to have produced the scoreboard.

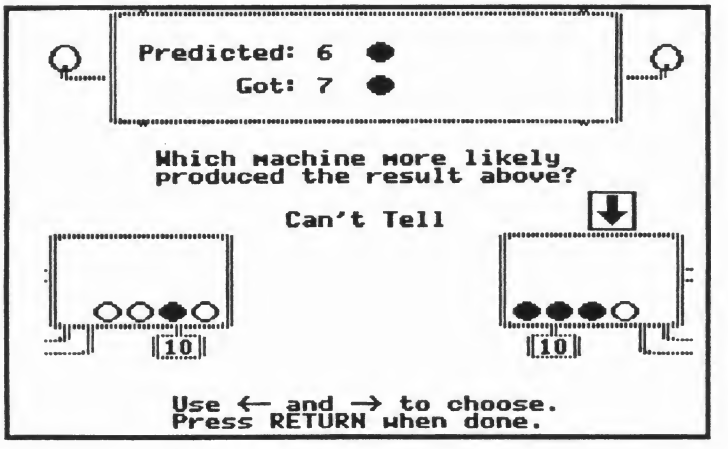


Students use the arrow keys (←,→) to select the machine most likely to have produced the scoreboard and press RETURN. Both correct and incorrect answers will result in a chance to work with the SAME SET (to review strategies), select a DIFFERENT SET of machines and scoreboards, or return to the MAIN MENU. If students choose the incorrect machine several times, they will be given a chance to return to the Work Room and test the machine.

When students choose a DIFFERENT SET they will receive a new scoreboard and a new set of machines. If the Teacher Option is set to SEQUENTIAL, each new set of machines will contain one more marble than the previous set of machines. If it is set to RANDOM, the computer will randomly generate a new set of machines.

Quality Control Room 2

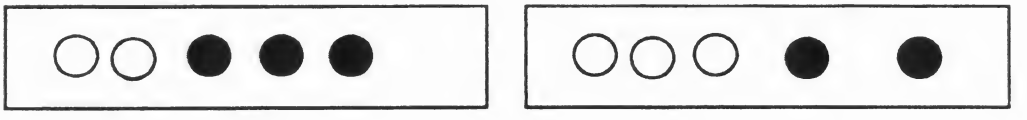
Quality Control Room 2 also shows two machines and a scoreboard. *Sampling with replacement* has occurred, that is, after a marble has been ejected it returns to the machine.



Students must decide which of the machines is more likely to have produced the scoreboard. When there is a good chance, such as 50/50 or 60/40, that either machine could have produced the scoreboard, then students should select CAN'T TELL.

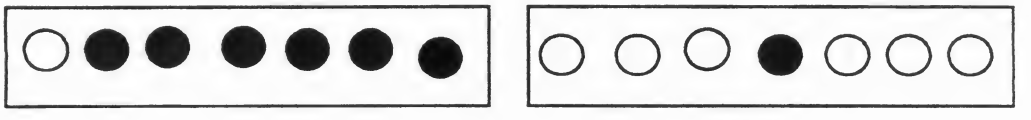
For example, CAN'T TELL is correct in the example below, because it is equally probable that 5 white marbles were ejected from either machine.

Predicted: 6 white out of 10 tries
Got: 5 white out of 10 tries



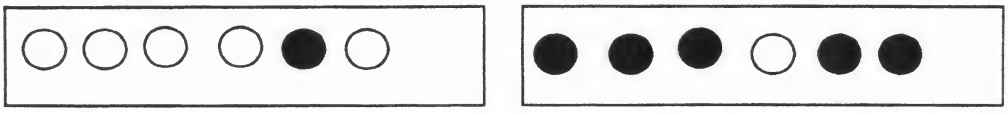
Or here, because it is equally improbable that 5 black marbles were ejected from either machine.

Predicted: 5 black out of 10 tries
Got: 5 black out of 10 tries



The CAN'T TELL choice is not correct here because it is more probable that 9 black would be ejected from the machine on the right since there are more black marbles in that machine.

Predicted: 8 black out of 10 tries
Got: 9 black out of 10 tries



As students work in Quality Control Room 2, they will learn that it is not the prediction, but the actual outcome that will give them clues to select their answer.

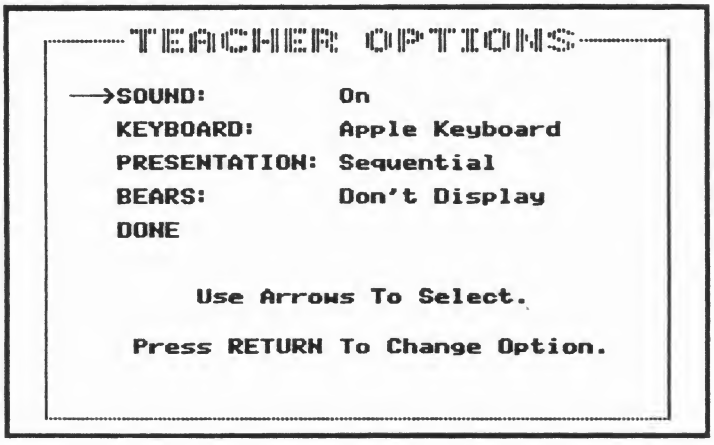
Students use the arrow keys (←,→) to select a machine or the CAN'T TELL option, and press RETURN to confirm their choice. After several incorrect choices, students will be given a chance to go the Work Room and test the machine.

After each problem, students may choose SAME SET, which allows them to confirm predictions and to check the data by working with the same machines and scoreboard. Or, they may choose DIFFERENT SET to get a new scoreboard and a new set of machines. If the Teacher Option is set to SEQUENTIAL, each new set of machines will contain one more marble than the previous set of machines. If it is set to RANDOM, the computer will randomly generate the marbles for the new machines.

Students may also select another room or exit the program by returning to the MAIN MENU.

TEACHER OPTIONS

The TEACHER OPTIONS can be accessed by pressing CONTROL-T while the Main Menu is displayed. Use the arrow keys and RETURN to choose each option. After making changes, select DONE and press RETURN.



Sound

Sound can be turned ON or OFF.

Keyboard

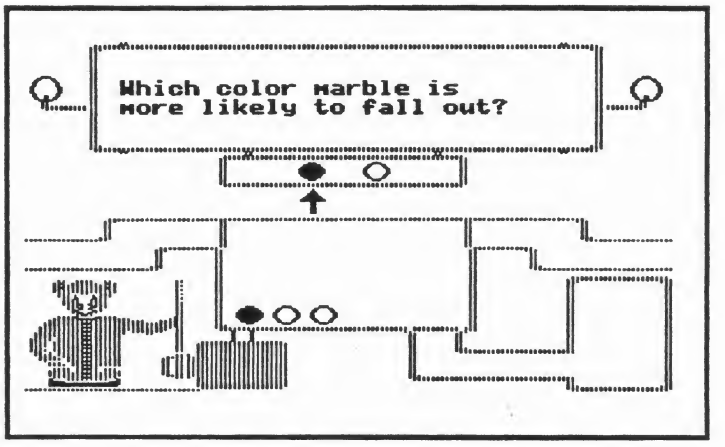
Taking Chances works on both the computer keyboard and the Muppet Learning Keys™.

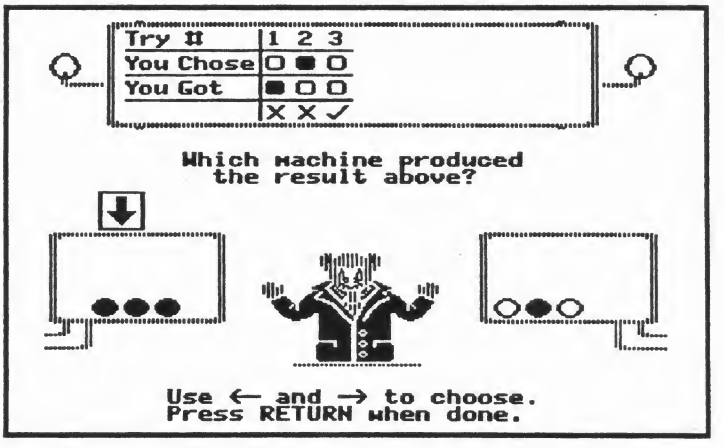
Presentation

Problems may appear sequentially or randomly. SEQUENTIAL means that the machines in the Work Rooms and Quality Control Rooms will produce one more marble each time DIFFERENT SET is selected. RANDOM means that the number of marbles will be randomly chosen each time DIFFERENT SET is chosen.

Bears

Taking Chances features an animated bear (shown below) who works the machine if the teachers select DISPLAY ON. The bear may motivate younger children. Older children may prefer to work without the bear, in which case teachers should select DON'T DISPLAY.





TARGETS: A NUMBER GAME
TABLE OF CONTENTS

Introduction..... 1

Objectives..... 4

Program Description..... 5
- How to Play..... 5
- The Championship Game..... 8
- Change Option.....11

Suggestions for Classroom Use.....12

Apple: Working with the Computer.....13

Atari: Working with the Computer.....14

TRS-80: Working with the Computer.....15

"What Happens If...?" Sunburst Courseware and Warranty.....16

Here's a sample problem. Use the numbers 5 and 6 (any amount of 5's and 6's that you need) to add up to 35. Easy. 5+5+5+5+5+5+5. But here's another way: 5+6+6+6+6+6. Is there a third way?

In playing TARGETS, children can choose the target (any number from 0 to 99) and the computer chooses the two numbers (like 5 and 6 in the example above) or the player can choose the two numbers (from 1 to 9) and the computer chooses the target.

Suppose the target were 27 and the numbers 5 and 6. This time you may have to think hard. How about 5+5+5+6+6? Is there another way?

Now suppose the numbers are 5 and 6 and the target 9. If only addition is allowed, there is no way to hit the target. Some problems in TARGETS are impossible, some very transparent, and some require a great deal of complex thinking.

In Level 1, only addition is allowed.

In Level 2, both addition and subtraction are allowed. Can you use 3 and 5 to make 1? How about 3+3-5? Is there another way? How about using 3 and 6 to make 1? Impossible! Only multiples of three are possible with 3 and 6.

In Level 3, all four operations--addition, subtraction, multiplication and division are allowed. In Level 3, all targets are possible. For example, suppose the two numbers are 4 and 6 and the target 31. There are easier ways to get 31, but one could add thirty-one 6's and then divide by 6.

In Level 3, an issue of major algebraic importance arises. What is 6+3x5? Working from left to right, one could add the 6 and 3, then multiply by 5. This result is 45. But one could also see the 3 x 5 as 15, then add the 15 to 6 to get 21. Which is right? Both are. The situation is totally ambiguous. To clarify the issue, mathematicians have introduced a convention--do the operation in parentheses first. Then (6+3)x5 is 45 and 6+(3x5) is 21. In TARGETS, parentheses are automatically entered by the computer in complex Level 3 "equations." The computer always adds parentheses in a sequential order. That is, it places parentheses around the quantities preceeding any multiplication or division sign, for example: ((3+1)x3+1)÷3.

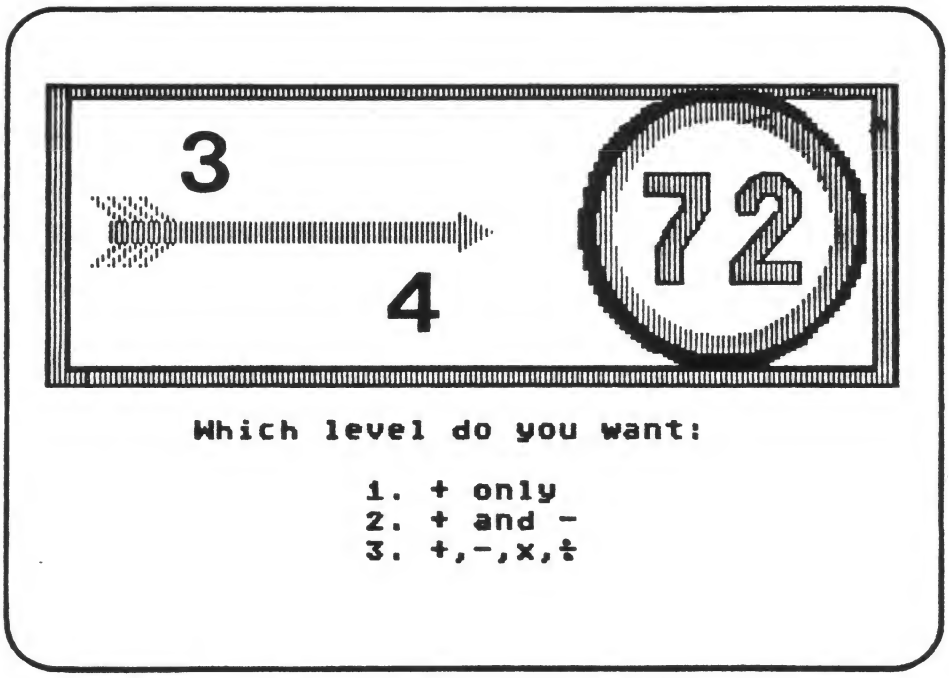
At each level in TARGETS, players play a first round where they can choose the target or the numbers. Then if they succeed, they can play a Championship Game. If they use fewer steps then the Champion, their name and score and "equation" are stored by the computer for others to challenge.

In general, TARGETS enables players to think mathematically in problem solving situations involving numbers. Certainly children will learn a great deal about numbers and about the four operations (and gets lots of practice in arithmetic while doing so), but TARGETS goes far beyond narrow computational skills. What TARGETS does is enable children:

- to construct and test hypotheses,
- to think combinatorially,
- to make decisions about pathways to a goal (and to choose the simplest from several such pathways),
- to distinguish between possible and impossible, and,
- perhaps most important, to see mathematics as thought and action rather than as a bunch of a static magic unconnected facts and recipes.

As Polya says, mathematics is not a spectator sport.

TARGETS: A NUMBER GAME



Prerequisite Skills: addition, subtraction, multiplication and division of numbers up to 99.

Students Work With: addition, subtraction, multiplication, division, logic

Grade Level: 3 - adult

Reading Level: 3rd grade

Time Required: 5 minutes per game

Objectives:

1. to practice basic operations
2. to invent the most efficient solution to a problem
3. to construct and test hypotheses
4. to think combinatorially
5. to distinguish the possible from the impossible

PROGRAM DESCRIPTION

TARGETS: A NUMBER GAME uses basic numerical operations to develop problem solving skills.

The game involves

1. a pair of numbers from 1-9,
2. the operation(s) to be used with the numbers, and
3. a target number from 0-99.

Students must combine the two numbers using the operation(s) to arrive at the target number.

There are three levels of play. In the first level, students add any combination of the two numbers to reach the designated target. Level 2 lets students use addition and/or subtraction. In the third level, students work with addition, subtraction, multiplication and division to reach their target.

Students have the option of choosing either the numbers or the target. If they choose the two numbers, the computer will randomly select the target. If they choose the target, the computer selects the two numbers.

Once students have succeeded at a level, they can play a Championship Game. The computer has 30 Championship Games stored for each level. One of those games is randomly chosen determining the numbers and the target the students may use. The students try to reach the given target number in the smallest number of steps. If they beat the current champion, their name and solution is recorded.

How to Play

In the beginning of the program, students are given instructions on how to play. Students are then asked:

Which level do you want:

1. + only
2. + and -
3. +, -, x, ÷

Enter 1, 2 or 3:

Students should begin playing TARGETS on the first level.

Students then choose if they want to select the numbers or the target. If the students want to select the numbers, they will be asked to:

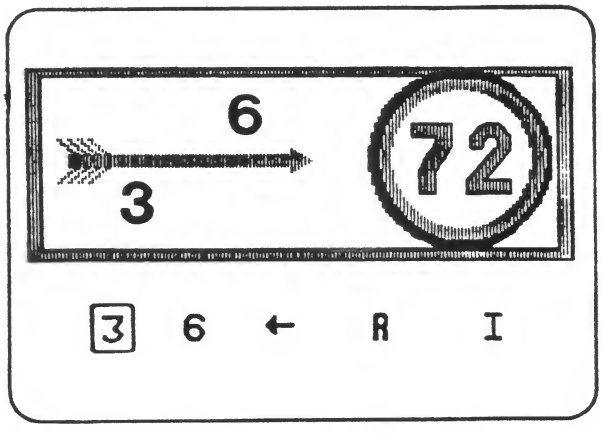
Enter a number (1 to 9):

Enter a different number (1 to 9):

If they want to select the target, they will be asked to:

Enter a target number from 0 to 99:

If students enter the numbers, the computer will choose the target. If they choose the target, the computer will select two numbers.



The target is then displayed on the top of the screen as shown above. The numbers the students work with are listed on the bottom of the screen along with:

← Erases the last number or sign entered.

R Restart. Erases the student's solution to this point and starts over.

I Impossible. The solution is not possible with the numbers selected and operations allowed.

Students move the selection box using the < or > keys on the Atari or the ← or → keys on the Apple or TRS-80 until it shows the response they want and then press RETURN or ENTER. A new set of options will appear which include the allowable operations (depending on the level) and:

→ Erases the last number or sign entered.

R Restart. Erases the entire answer to this point and starts over.

I Impossible. The problem is not possible with the numbers selected and operations allowed.

The students continue to choose numbers and operations until they reach their target. The number of steps and their current total is displayed and updated on the screen. (Students are restricted from totals more than 100,000.)

Students may use up to 50 steps on the Atari or 32 steps on the TRS-80 to reach a target. However, efficiency is one objective of TARGETS. Students should be encouraged to reach their target in the smallest number of steps.

Reaching the Target

Once students reach the target, the computer automatically prints:

You reached the target!!!

The students then choose from:

1. Play the same game
2. Play a different game
3. Play a Championship Game
4. Choose a different level
5. End

1. Play the same game

If students choose option 1, they will be given the same variables used in the last game (the same numbers, target and operation(s)). Thus, they can try to improve on their previous play.

2. Play a different game

Selecting option 2 lets the student choose a different target or different numbers keeping the operation(s) the same as the last game.

3. Play a Championship Game

If option 3 is selected, the screen will show the student who holds the record for the Championship Game and the number of steps taken. Students try to set a new record (see page 8 for more information).

4. Choose a different level

If students select the last option, students are returned to the menu:

Which level do you want?

1. + only
2. + and -
3. +, -, x, ÷

Enter 1, 2 or 3:

Stopping

At any time, students may stop by holding the CONTROL key and pressing the E key on the Atari or by holding Shift key and down-arrow key while pressing the E key on the TRS-80. This will bring them to:

1. Play the same game
2. Play a different game
3. Choose a different level
4. End

The End option will allow them to insert a new diskette or turn off the computer.

The Championship Game

At each level, 30 championship games are available. When students select the Championship Game, one of the games is randomly chosen. The Championship Games are devised to provoke complex thinking by the students.

The Championship Games consist of two or three numbers and a target. If students have been playing Level 1 games, they will receive Level 1 problems. The same is true of Levels 2 and 3.

If students complete the Championship Game in fewer steps than the existing record, their name, number of steps, and solution will be recorded in the computer. The teacher can monitor these scores through the Change Option (see page 11).

If students complete the problem in more steps or an equal number of steps, they will not be named the new champion. The champion's score and solution will be displayed. If the teacher does not wish the solution to be shown, it can be turned off in the Change Option (see page 11).

LEVEL 1

LEVEL GAMES	NUMBERS			TARGET	MINIMUM STEPS
Game 1	9	7		56	Steps= 8
Game 2	1	6		25	Steps= 5
Game 3	1	3	9	17	Steps= 5
Game 4	2	5	9	23	Steps= 3
Game 5	2	5	9	38	Steps= 5
Game 6	2	3	8	40	Steps= 5
Game 7	2	7	8	41	Steps= 6
Game 8	3	5	8	33	Steps= 6
Game 9	3	6	8	72	Steps= 9
Game 10	3	8	4	60	Steps= 8
Game 11	4	5		62	Steps= 13
Game 12	4	8		72	Steps= 9
Game 13	5	6	3	51	Steps= 9
Game 14	5	7	3	24	Steps= 4
Game 15	6	7	3	50	Steps= 8
Game 16	6	8	3	66	Steps= 9
Game 17	7	8	3	37	Steps= 5
Game 18	7	9	3	78	Steps= 10
Game 19	8	9	3	80	Steps= 9
Game 20	5	8	7	58	Steps= 8
Game 21	2	3		22	Steps= 8
Game 22	3	7		24	Steps= 4
Game 23	3	8		38	Steps= 6
Game 24	4	5		49	Steps= 10
Game 25	4	7		36	Steps= 6
Game 26	5	7		45	Steps= 7
Game 27	5	8		40	Steps= 5
Game 28	6	7		33	Steps= 5
Game 29	7	9		32	Steps= 4
Game 30	8	9		51	Steps= 6

LEVEL 2

LEVEL GAMES	NUMBERS			TARGET	MINIMUM STEPS
Game 1	1	5	3	14	Steps= 4
Game 2	1	7	8	68	Steps= 9
Game 3	2	3		13	Steps= 5
Game 4	2	5	4	52	Steps= 11
Game 5	2	9		41	Steps= 7
Game 6	3	5	1	27	Steps= 7
Game 7	3	8		4	Steps= 5
Game 8	3	8	9	24	Steps= 3
Game 9	4	7		10	Steps= 3
Game 10	4	9		2	Steps= 6
Game 11	5	6	7	88	Steps= 13
Game 12	5	7		11	Steps= 5
Game 13	5	9		1	Steps= 3
Game 14	5	9		3	Steps= 5

(Level 2 cont'd.)

Game 15	6	7	8	22	Steps= 3
Game 16	6	8	9	4	Steps= 4
Game 17	7	9		4	Steps= 4
Game 18	7	8	3	25	Steps= 4
Game 19	3	5		37	Steps= 9
Game 20	8	1	4	43	Steps= 7
Game 21	2	4		48	Steps= 12
Game 22	2	5		4	Steps= 2
Game 23	2	7		10	Steps= 4
Game 24	3	5		22	Steps= 6
Game 25	3	7		11	Steps= 3
Game 26	4	7		9	Steps= 5
Game 27	5	8		1	Steps= 5
Game 28	6	8		42	Steps= 6
Game 29	7	8		29	Steps= 4
Game 30	8	9		12	Steps= 7

LEVEL 3

LEVEL GAMES	NUMBERS			TARGET	MINIMUM STEPS
Game 1	3	5	4	14	Steps= 3
Game 2	1	6	5	12	Steps= 2
Game 3	9	8	6	71	Steps= 4
Game 4	5	8	7	6	Steps= 3
Game 5	5	9	8	48	Steps= 3
Game 6	1	3	4	48	Steps= 3
Game 7	1	5		20	Steps= 3
Game 8	3	4		13	Steps= 3
Game 9	3	4	5	22	Steps= 3
Game 10	3	7	4	44	Steps= 3
Game 11	3	9	8	28	Steps= 4
Game 12	4	9	5	77	Steps= 3
Game 13	5	9	3	33	Steps= 4
Game 14	6	7	8	67	Steps= 5
Game 15	7	8		4	Steps= 5
Game 16	6	8	3	10	Steps= 3
Game 17	8	9		51	Steps= 6
Game 18	8	3	4	64	Steps= 2
Game 19	3	4		81	Steps= 4
Game 20	1	4		65	Steps= 4
Game 21	2	3		80	Steps= 6
Game 22	3	7		2	Steps= 3
Game 23	3	8		61	Steps= 3
Game 24	4	7		30	Steps= 4
Game 25	4	9		2	Steps= 3
Game 26	5	6		66	Steps= 3
Game 27	5	9		56	Steps= 5
Game 28	2	6		17	Steps= 4
Game 29	6	9		80	Steps= 5
Game 30	8	9		74	Steps= 5

CHANGE OPTION

To access the Change Option, press a CONTROL T on the Atari or the Shift key, down-arrow and the T key on the TRS-80. The Change Option can be accessed at the level menu or the option where you decide to play again, play a new different game, a Championship Game, or choose a different level.

The teacher will be given these options:

1) View Champions/Change Name
2) Reset Scores
3) Display Solutions
4) Return to Targets

View Champions/Change Name

The view option allows the teacher to see the name of the student holding the record for a given game at a given level and the number of steps used. A star or dot is placed in front of the student's name if the number of steps taken is the smallest possible. The teacher is then asked "Do you want to change a name?" If yes, the number of the name to change and the name are entered. If no, scores at the next level will be printed. A CONTROL E (or Shift, down-arrow, E) will bring you back to the list of change options.

Reset Scores

The reset option allows the teacher to delete all the names and delete the names from any level. This could be used at the end of a quarter or the end of the year.

Please note: Resetting on the Atari may take up to ten minutes so plan accordingly.

Display Solutions

The teacher has the option to suppress the printing of the champion's solution when another student does not beat the champion. Students can gain knowledge by looking at another student's solution. But if the teacher feels their students will want to copy the solutions, this option may be turned off by answering NO to the question "Should the students see the answer?" If the teacher has typed "NO," after students complete a Championship Game and do not beat the champion, they will be given only the champion's name and number of steps.

TIP 'N FLIP

TABLE OF CONTENTS

Introduction..... 1

The Problem Solving Skill Matrix..... 3

Program Description..... 4

Ideas for Classroom Use..... 7

Can You See the Difference - Classroom Lesson 1..... 8

Puzzle Flipping - Classroom Lesson 2..... 12

Software Strategy Lesson - Game One..... 17

Software Strategy Lesson - Game Two..... 21

Sharing Some Field-Testing Observations..... 28

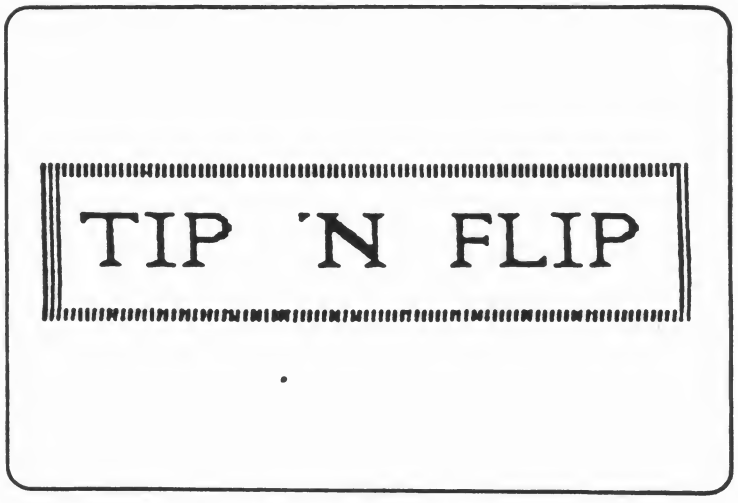
"What Happens If...?"
Sunburst Courseware and Warranty..... 29

Apple II: Working With Your Computer..... 30

Apple IIGS: Control Panel Settings..... 31

IBM PC/PCjr: Working With Your Computer..... 32

PROGRAM DESCRIPTION



SKILL OR STRATEGY: Visual discrimination
Working backward
Analyzing
Problem finding

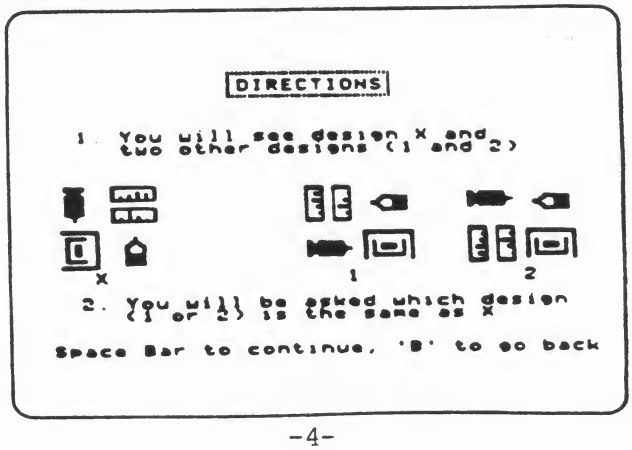
GRADE: 4-12

READING LEVEL: 4th grade (for directions)

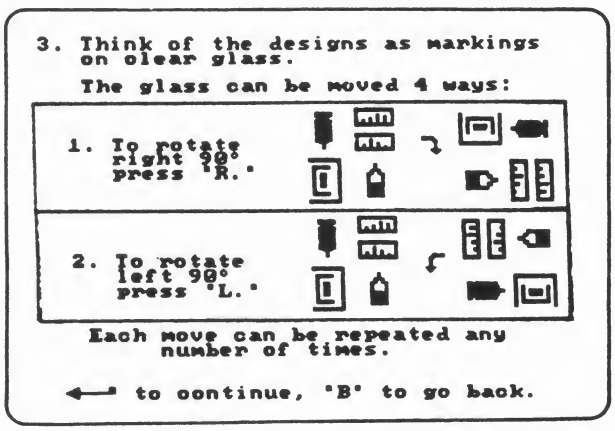
TIME REQUIRED: Approximately 15 minutes per game (varies widely with student ability and number of problems selected)

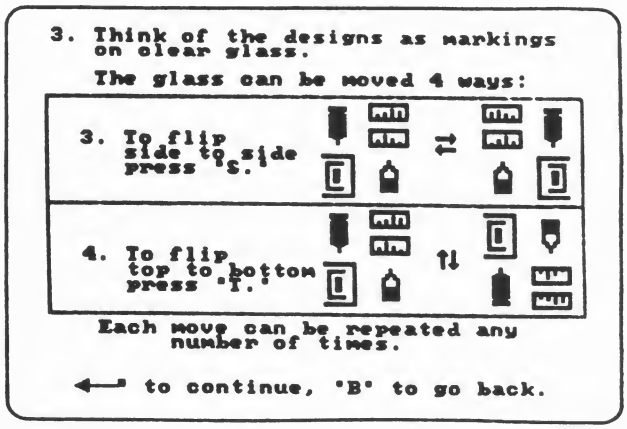
TIP 'N FLIP is designed for grades four through twelve and provides practice in spatial problem solving. Two versions of the game can be played. Game one has four levels of difficulty. Game two has three levels of difficulty. Up to ten problems may be selected at each level.

In Game One, the player is shown one design that is set apart from two other designs. One of the designs in the group of two is the same as the first design, but it may have been rotated to the right or left or flipped side to side or top to bottom.

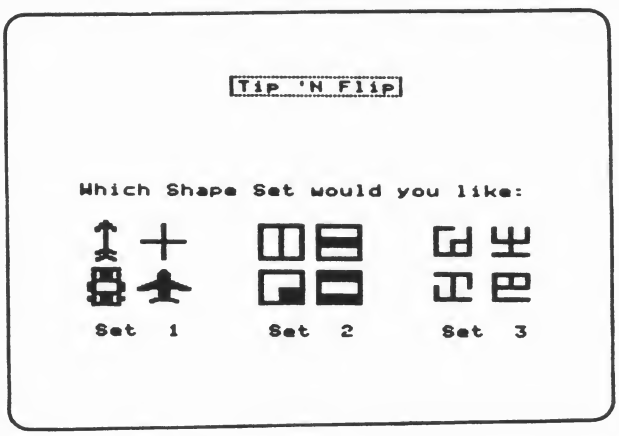

DIRECTIONS
1. You will see design X and two other designs (1 and 2)
X
1
2
2. You will be asked which design (1 or 2) is the same as X
Space Bar to continue, 'B' to go back

The object of the game is to select a design (from a pair of designs) that is the same as the first design. This is done by mentally flipping the design until it matches the desired pattern.

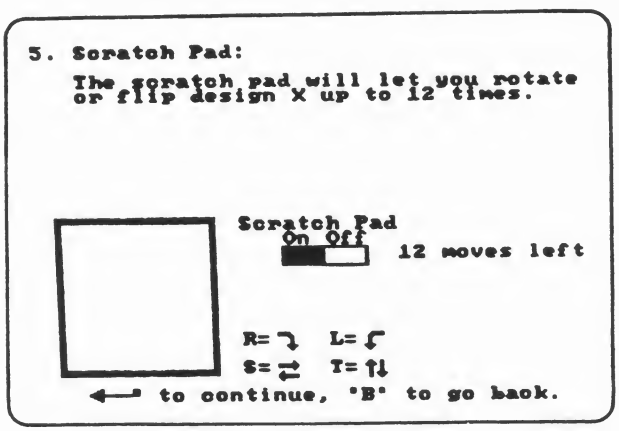

3. Think of the designs as markings on clear glass.
The glass can be moved 4 ways:
1. To rotate right 90° press 'R.'
2. To rotate left 90° press 'L.'
Each move can be repeated any number of times.
to continue, 'B' to go back.


3. Think of the designs as markings on clear glass.
The glass can be moved 4 ways:
3. To flip side to side press 'S.'
4. To flip top to bottom press 'T.'
Each move can be repeated any number of times.
to continue, 'B' to go back.

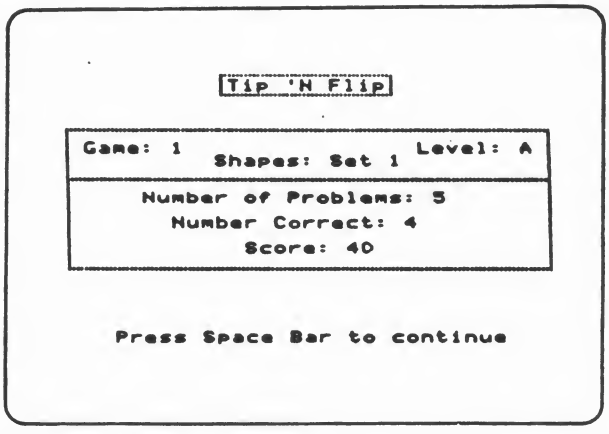
The player is allowed to select the shapes to be used in the game.



A SCRATCH PAD is available if a player needs help. The SCRATCH PAD lets a player rotate or flip the design before making a choice. Use of the SCRATCH PAD will cost the player one point for each move made.

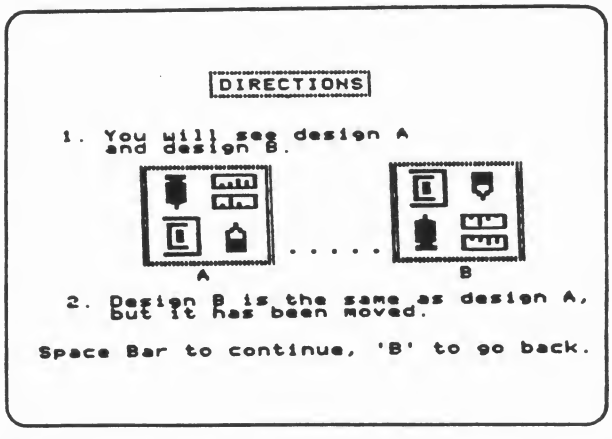

5. Scratch Pad:
The scratch pad will let you rotate or flip design X up to 12 times.
Scratch Pad
On Off
12 moves left
R= L=
S= T=
to continue, 'B' to go back.

Upon completion of the game, the number of problems attempted, the number correct and the score are displayed. Each correct answer earns 10 points. Remember that each use of the scratch pad costs one point.



In Game Two, two designs are shown. The second design is the same as the first, except that it has been rotated right or left, flipped side to side or top to bottom, or moved using some combination of the four (RLST).

The object of the game is to find the moves that will make the first design match the second.


DIRECTIONS
1. You will see design A and design B.
A
B
2. Design B is the same as design A, but it has been moved.
Space Bar to continue, 'B' to go back.

A correct answer earns a player ten points. The shortest answer earns an extra two points. Each move made with the scratch pad will cost one point.

The player uses the keys R, L, S, T to indicate Right, Left, Side to Side or Top to Bottom moves. A combination of moves such as "RS" would mean a right rotation followed by a side to side flip.

A SCRATCH PAD is again available if a player needs help. The SCRATCH PAD lets a player rotate or flip the design before making a choice. Use of the SCRATCH PAD costs the player one point for each move made.

Upon completion of the game, the number of problems attempted, the number correct and the score are displayed.

TRADING POST

TABLE OF CONTENTS

Introduction..... 1

Problem-Solving Skill Matrix..... 2

Objectives..... 3

Program Description..... 4
- General Description..... 4
- Exiting the Program.....13
- Change Option.....13

Classroom Ideas.....14
- Before Using Trading Post.....14
- Introducing Trading Post.....14
- Follow-up.....15
- Worksheet 1.....16
- Answer Sheet 1.....18
- Worksheet 2.....20
- Answer Sheet 2.....22
- Worksheet 3.....24
- Answer Sheet 3.....26

Apple: Working with the Computer.....28

Commodore 64: Working with the Computer.....29

IBM PC/PCjr: Working with the Computer.....30

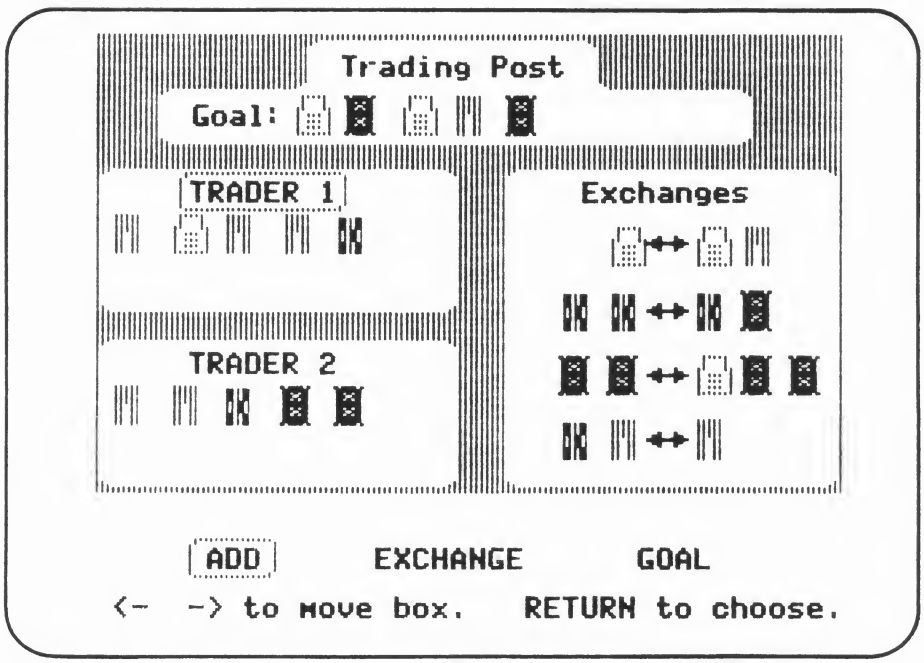
Tandy 1000: Working with the Computer.....31

TRS-80 Color: Working with the Computer.....32

"What Happens If...?" -- Sunburst Courseware and Warranty.....33

TRADING POST

OBJECTIVES



Skills: visual discrimination, rule formation, analyzing, identifying multiple solutions.

Grade Level: 3 - 7

Reading Level: 4th grade

Time Required: 2-10 minutes per game

Objectives:

1. to put students in a situation in which they must plan ahead and analyze.

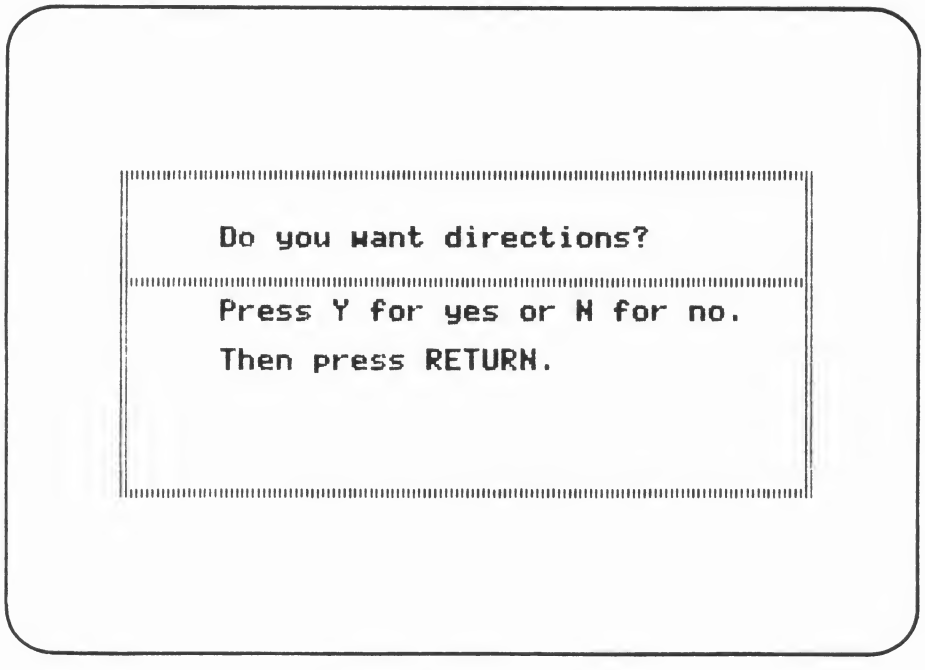
2. to require students to use a set of rules, which change in each game, to plan a strategy.

General Description

A title sequence will appear at the beginning of the program. Students can then proceed with the game by pressing:

RETURN - on the Apple II and Commodore 64
↵ - on the IBM PC/PCjr
ENTER - on the Tandy 1000 and TRS-80 Color

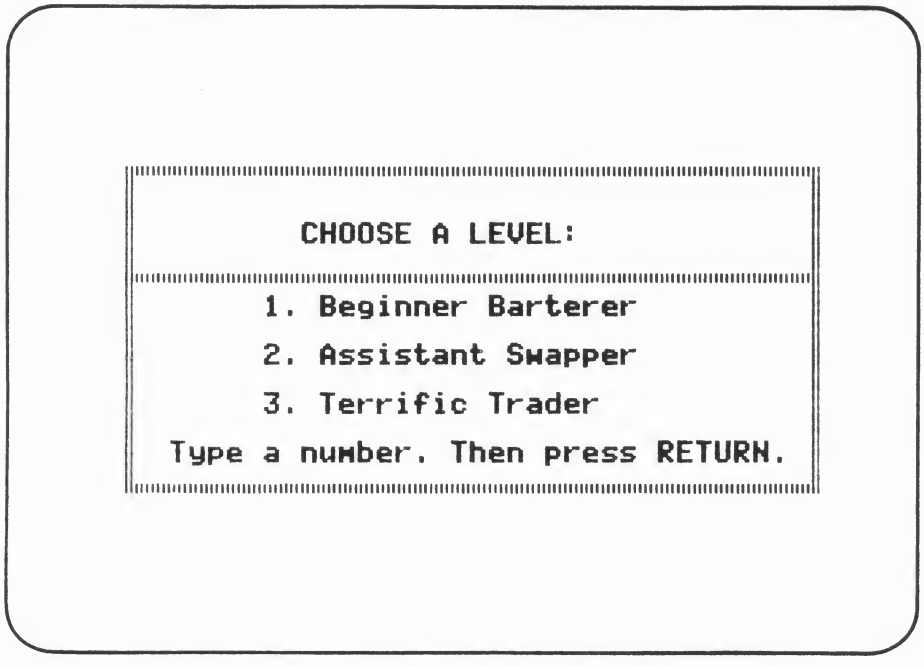
Students will then be asked if they want directions.



Students can answer "yes" to see the directions, or they can answer "no" to skip directions and begin the game.

Students will then be asked their name. If a student proceeds without entering a name, the name TRADER 1 or TRADER 2 will be assigned.

Students will then be asked which game they want to play.

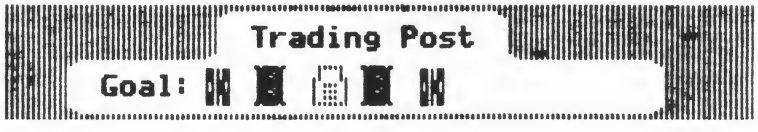


- If students choose Beginner Barterer, they will be given a goal of 5 shapes. The exchanges in this game are always even. This means that one shape will be exchanged for one shape, two shapes for two shapes, etc.

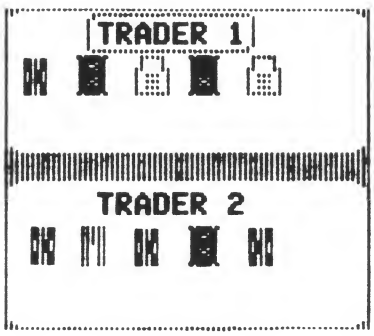
- If they choose Assistant Swapper they will be given a goal of 5-6 shapes. Exchanges at this level may be even or uneven. Uneven means that one shape may be exchanged for two, two for three, or one for three shapes.

- If Terrific Trader is chosen, the goal will consist of 7-8 shapes. Exchanges in this game are even and uneven.

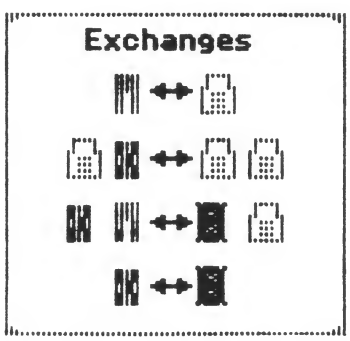
As students begin the game, they will see the goal, the starting shapes for each student, and a set of Exchange Rules. The goal consists of five to eight shapes chosen at random by the computer.



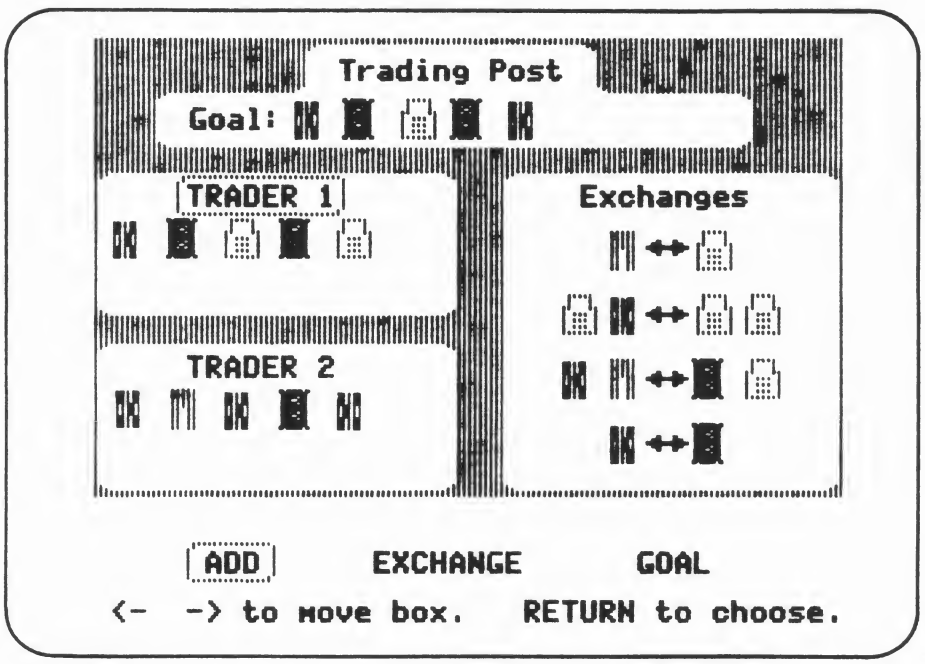
Each student begins with 5 shapes chosen by the computer.



The Exchange Rules box contains four rules which allow the students to exchange their shapes according to these rules. The rules are also chosen at random and might look like this:



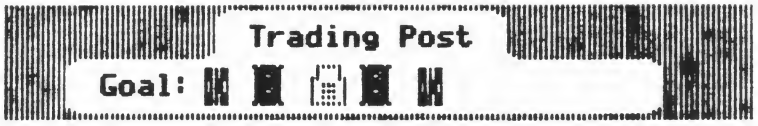
TRADER 1 begins the game and may choose one of the 3 options available, as shown below:

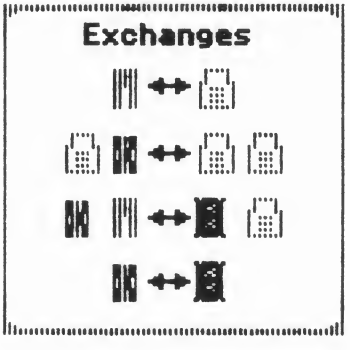


ADD: If students choose ADD, the computer adds one shape to their collection. The box at the bottom of the screen is already positioned around ADD, and students need only to press RETURN (Apple II, Commodore 64), ↵ (IBM PC/PCjr), or ENTER (Tandy 1000, TRS-80 Color) in order to add one shape.

The computer picks the shape at random. If a student already has twelve objects, the computer will take away one object since each student is limited to twelve shapes.

If this situation occurs,

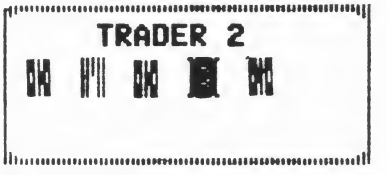




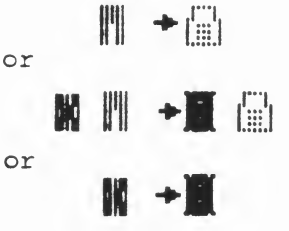
students might choose the ADD option to get a shape from the computer. None of the exchanges that they could make would help them toward the goal.

EXCHANGE:

If students have a situation like this and the same exchange rules apply,



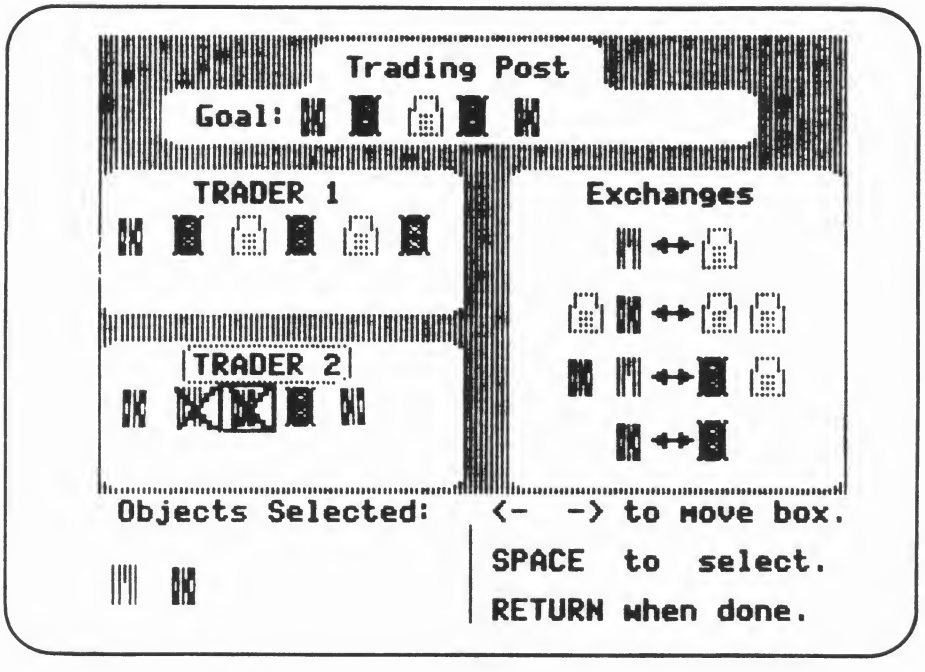
they might choose to make an exchange. There are several exchanges which could be made in this situation in order to get closer to the goal. Students could exchange as follows:



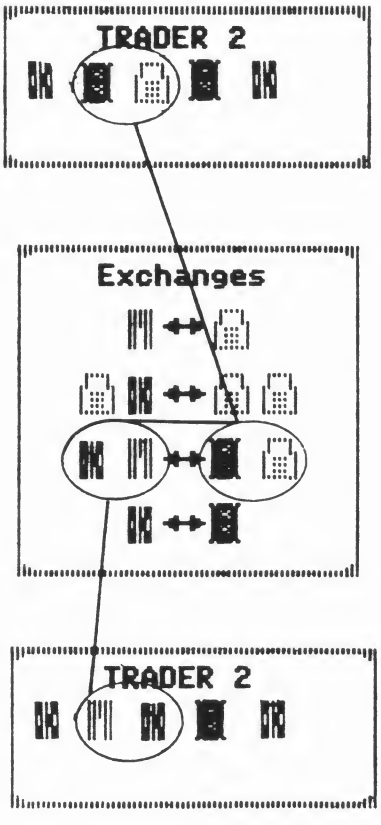
The students may exchange the shape(s) on the left side of the ↔ sign to get the one(s) on the right side; they can also exchange the shape(s) on the right side of the arrow to get the shape(s) on the left side.

After an exchange has been decided upon, students move the box to EXCHANGE by using the arrow keys (Commodore 64: < , >).

A box then appears around the first shape in the trader's collection. Students move the box to one of the shapes they want to exchange and press the SPACE BAR. The shape they have selected will be crossed out (on the Commodore 64, the shape's color will change). That shape will also appear under Objects Selected.



Students may choose another shape or as many shapes as are necessary for the exchange. They then press RETURN (Apple II, Commodore 64), ↵ (IBM PC/PCjr) or ENTER (Tandy 1000, TRS-80 Color). IF the shape(s) which have been selected for exchange fit one of the Exchange Rules, the computer will substitute the shapes according to the rules.



If the shapes selected for exchange do not fit the rule, students lose a turn.

GOAL:

When the students think that their set of shapes contains all the shapes in the goal, they can select GOAL. The shapes do not have to be in the same order and there may be extra shapes that do not match the goal.

For example, here TRADER 1 has the items needed to match the goal.

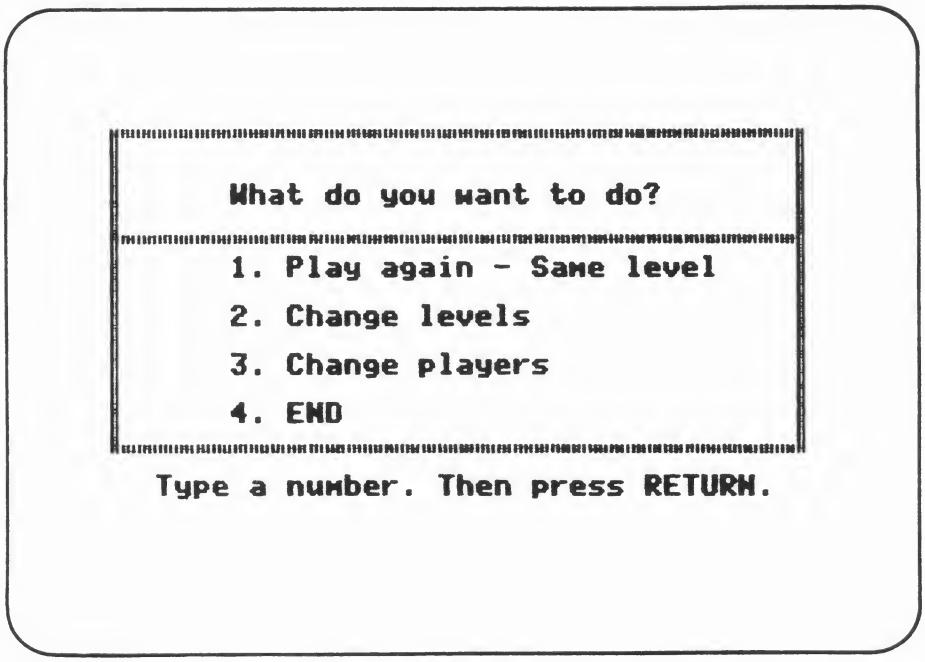
After TRADER 1 has selected the Goal Option, the computer checks the two sets. If the goal is reached, the matched shapes are removed and that trader is declared a winner. If the goal is not reached, the trader loses a turn.

When a winner is declared, a score is shown and a new game is started. The losers keep all of their shapes while the winners' set is replenished to five shapes.

A student who has reached the goal twice is rewarded with a picture and his/her name is printed in as the winner.

Exiting the Program

After the game is completed, students will be able to:



Students may stop a game at any time by doing the following:

- Apple II, Commodore 64, IBM PC/PCjr, Tandy 1000: hold down the CONTROL (CTRL) key, and press the E key.
- TRS-80 Color: hold down the SHIFT and down arrow keys, and press the E key.

Change Option

TRADING POST has a Change Option allowing the teacher to choose whether the sound will be on or off during the program. It can be accessed when the question "Do you want directions?" is displayed by doing the following:

- Apple II, IBM PC/PCjr, Tandy 1000: hold down the CONTROL (CTRL) key and press the T key.
- Commodore 64: hold down the C= key and press the T key.
- TRS-80 Color: hold down the SHIFT and down-arrow keys, and press the T key.

A screen will then appear with the question: "Do you want sound on?" To turn the sound on, answer "yes" to the question. Once the sound is turned on, it remains available everytime the diskette is used, until it is turned off with the Change Option.